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ON THE COVER

THE huge twin tunnels that will carry water under the City of Niagara Falls, Canada, to the new downstream 1,200,000-hp hydroelectric generating station are being lined with 3 feet of concrete. Our cover picture shows the scaffolding required to carry the pipes that convey the mixture into the form for the arch and wall sections. Concrete mixed on the surface is chuted into each bore through large drilled holes into a receiving gantry and thence into the hoppers of a pouring gantry from which it is pumped into the form. The latter is moved on a truss structure to each successive pour location. The invert, amounting to one-sixth of the circle, is paved first.

IN THIS ISSUE

DURING the past 25 years there has been a minor revolution in methods of railway track maintenance. Ingenious machines of various kinds have now replaced some of the small armies of section hands that formerly swarmed over the rights of way, and the trend continues. Squeezed between growing competition from other forms of transportation and a shortage of labor with accompanying high wages, the rail carriers were forced to mechanize upkeep operations and have succeeded remarkably well. Among the latest labor-saving devices is an air-powered ballast tamper that enables one man to run sixteen tools in unison. It retains all the time-proved advantages of air tamping and substitutes never-tiring pneumatic energy for fatigue-vulnerable human muscles. Page 236.

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THE hydroelectric power tunnels at Niagara Falls are the largest of their length ever driven. Their enormous cross section has created special problems in both excavating and concreting them. The canal that will receive water from the tunnels is another huge opening, and equipment of large size was utilized in digging it. Details of both these outsize muck-shifting jobs are given in the second and concluding article on this subject. Page 244.

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IT HAS been just 20 years since the appearance of the first Impactool—then known as the "Pott impact wrench." No other tool developed in the same period has proved to be a greater time and money saver. Apparently, these advantages increase somewhat in proportion to the size of the nuts handled. A case in point is described and illustrated on pages 242-43.

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EDITORIAL CONTENTS

Making Beds for Iron Horses—*C. H. Vivian* 236
Striking Savings Made with Large Impactools 242
More Canadian Kilowatts at Niagara, Part 2—*H. R. Rice* 244
In Texas They Blow Off Home Plate 251
Pseudo Atomic-Ray Bombarder 252
Editorial—Return of the Sockeye 254
This and That 255
Beer Cases Make Homes for Fish 255
Jap Pillbox Resists American Air Tools 257
Oxygen Equipment for the Mount Everest Expedition 258
Mines Need Big Fans to Supply Ventilating Air 258
Industrial Notes 259
Quotes from Here and There 262
Books and Industrial Literature 263

ADVERTISING CONTENTS

Allis-Chalmers Mfg. Co. 7
Allis Co., The Louis 16
Anaconda Copper Mining Co. 29
Bethlehem Steel Company 8
Combustion Engineering, Inc. 17
Compressed Air Magazine Co. 18
Cook Mfg. Co., Inc. C. Lee 20
Coppus Engineering Corp. ..... 2nd Cover
Crucible Steel Co. of America 33
Dollinger Corporation 3
Eimco Corporation, The 21, 22
Elliott Company 26
Galland-Henning Mfg. Co. 12
Goodall Rubber Company 19
Hansen Mfg. Co., The 6
Hercules Powder Company 27
Ingersoll-Rand Company 4, 5, 28
3rd Cover
Johnson Corporation, The 19
Lake Shore Engineering Co. 18
Maxim Silencer Co., The 24
Naylor Pipe Co. 15
New Jersey Meter Company 20
Niagara Blower Company 13
Norton Company 10
Reliance Electric & Engr. Co. 32
Sarco Company 18
Sauerman Bros., Inc. 19
Schraders' Sons, A. 9
Square D Company 20
Texas Company, The ..... Back Cover
Timken Roller Bearing Co. 30
Toledo Pipe Threading Machine Co., The 23
Victaulic Co. of America 14
Vogt Machine Co., Henry 31
Walworth Company 25
Wisconsin Motor Corporation 11

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Making Beds for Iron Horses

Multiple Tie Tamper Enables One Man to Operate 16 Pneumatic Tools

C. H. Vivian

WELL-KEPT TRACK

A stretch of double track on the Norfolk & Western Railway. Clean, hard crushed-stone ballast fills the cribs between the ties and also the space between tracks.

BALLAST is to a railroad what springs are to a bed. A layer of clean stone, gravel, blast-furnace slag or even cinders beneath and between ties forms a resilient cushion that distributes the trainload over the subgrade, provides effective drainage and retards the growth of grass and weeds. After ballast has been in place for a time it has to be removed, cleaned and replaced because the voids between individual pieces become fouled with dirt, coal dust, etc. The operation includes adding ballast and raising, grading and lining the track. The interval between treatments is usually around four years but varies with the volume of traffic, the type of ballast used, the amount of rain or snowfall in the area, the character of the subgrade soil and other factors. However, the track is worked over less thoroughly at shorter intervals.

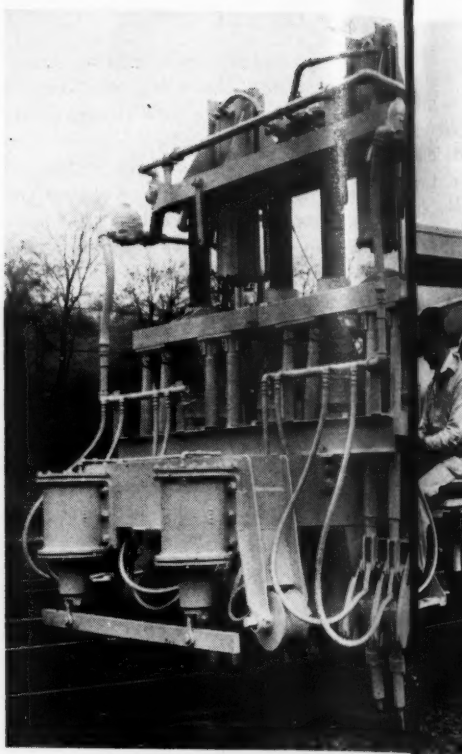
American railroads annually spend from 10 to 14 percent of their gross revenue for maintenance of way and structures, and the major share of the money goes for upkeep of track. What this means in the case of a large carrier was recently revealed when a Pennsylvania Railroad official stated that his line would spend approximately $135 million this year for maintenance of way. The Class I railroads, meaning those with an annual income of more than $1 million, renew ties at a rate of about 40 million per year and also lay an average of two million tons of new rail—the equivalent of 10,000 miles of track.

Crushed stone or smelter slag makes the best ballast, with gravel next best and cinders least effective. Stone exceeds the others in first cost, but once in place it is highly durable. Most railways use it or gravel on main-line tracks. Some roads carry crushed stone or slag several hundred miles to sections that lack deposits of hard rock. They are often able to do this economically because they can haul it in cars that would otherwise be returned empty to areas where major freight loadings originate. An example is the Pennsylvania which transports rock from New Jersey quarries to Pittsburgh and beyond in cars being taken back to the bituminous coal fields.

Good cinders make satisfactory ballast for track that is subjected to light traffic but, naturally, will not stand up like the harder materials. Railroad men say the quality of cinders deteriorated when hand firing of locomotives gave way largely to automatic stokers. For that matter, they point out that with the decisive turn to diesel traction the day is fast approaching when there'll be no cinders available for ballasting.

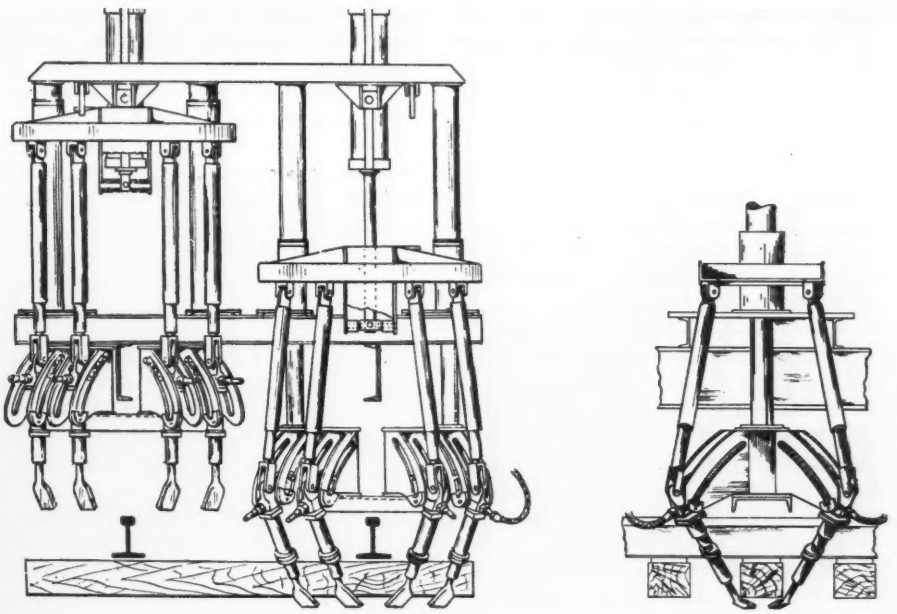
Tamping ballast under ties has always been a laborious task. In the beginning it was entirely a manual job, the section hands using forks or bars to work the material into place. Around 1910 it was realized that this could be accomplished with air power, and a pneumatic tamper was developed. The tools were at first operated with air that was taken from the pneumatic-signal supply lines and, consequently, could be utilized only where such a system existed. In 1913, Ingersoll-Rand Company introduced and began the manufacture of a car-mounted, self-propelled, gasoline engine-driven compressor for the purpose.

Thereafter, mechanical tamping increased rapidly. It was soon discovered that one man with a power tamper could accomplish as much as four to eight hand workers. However, as long as labor was plentiful and wages were relatively low, hand tamping continued on a considerable scale, especially on the smaller railroads and on the branch lines of large systems. As for that, it should be borne in mind that many men are called for even where conventional hand-held power tampers are utilized, because each machine requires an operator. It is customary for tampers to work together in multiples of four and in gangs ranging up to 32 in all.



SIXTEEN TOOLS IN ONE

With this machine, the McWilliams multiple tamper, one man operates sixteen pneumatic tie tampers and does work that formerly required sixteen men. Moreover, the machine works steadily, never tires, and each of the tampers follows the same path every stroke, thereby always producing the same results. This view clearly shows the system of piping and hose lines through which air reaches the individual tamping tools.



HOW TAMPERS OPERATE

The sketch at the left shows how the split head permits tamping under either rail, independently of the other, which is advantageous at rail joints and occasional low spots. The other sketch shows how the tamping bars of opposed tools come within 2½ inches of meeting at the low points of their strokes. The cams guide them in the same path each time they penetrate the ballast.

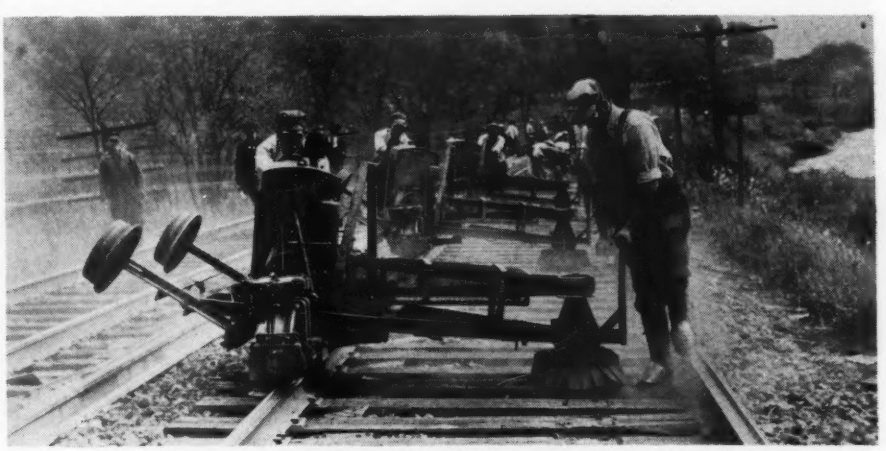
The outbreak of World War II caused an acute labor shortage. This greatly reduced track maintenance on all roads and virtually eliminated it on some of the busier ones. A contributing factor in the latter case was that the tracks were used so much there was no time to work on them. To illustrate this point we might mention that for many months a train passed over the main line of the Pennsylvania between New York and Washington every 4½ minutes, on the average.

On the whole, rail carriers came out of the war with roadways badly battered and in sore need of attention. But correcting the condition presented obstacles. In addition to growing scarcer, labor had become steadily more expensive, and the trend has continued. Track workers that earned around 40 cents an hour 20 years ago now get $1.50 or more. Under such a wage scale the cost of extensive hand tamping is prohibitive, and even where conventional hand-held power tampers are in service, so many men are required that few railroads can afford to carry out the maintenance programs they would like to schedule.

It was evident a decade ago that a way had to be found to reduce tamping costs. The obvious course was to devise a multiple-tool machine that would permit the labor charge to be spread thinner than is possible where an operator is needed for each tamper. In answer to the demand units of this type appeared, aroused the interest of all maintenance-of-way men and were adopted in varying degrees by the nation's railroads. None of these earlier machines is based on the principle of air tamping that has long been accepted as the best for the job. One of them depends upon vibration to work the ballast under the ties; the others upon the force of a falling weight to push or drive it under.

But in 1950 a machine was brought out that is equipped with the identical air-powered tampers that have proved effective for more than 40 years. Instead of an operator for each tool, one man runs sixteen of them mounted together and working in unison. This multiple tamper is built by Railway Maintenance Corporation, of Pittsburgh, Pa., and is called the McWilliams Tie Tamper after the firm's founder and president, J.B. McWilliams. It was developed primarily because the Pennsylvania Railroad, having had satisfactory experience with the hand-held pneumatic tool, wanted an air-powered machine that used the same principle. Especially interested was S.R. Hursh, assistant chief engineer of maintenance, and he collaborated with RMC in designing the first model. The latter had two carriages, each holding sixteen tampers and mounted on a self-propelled steel car 38 feet long and weighing 35,000 pounds. Eleven of the units were turned out and all were bought by the Pennsylvania, which is still using them successfully.

Engineers of many railroads looked the machines over carefully when they were put in operation. They were impressed by their performance, but most of them said that a smaller size would meet their needs better. One of the first things that comes to mind when the pur-



SMOOTHING TIE TOPS

Before new rail is laid on old ties, adzing machines cut uniform seats for tie plates. Head goes up and wheels at left come down when unit is moved.

chase of large and rather costly machines of this sort is being considered is how many hours of the day they can be used. Unless crews can work on a track with few interruptions, it is questionable whether a large capital investment is justified.

Much of the eastern part of the Pennsylvania system is 4-tracked, and it is consequently possible at times to take one track out of service for maintenance. Most other roads, however, have no more than two tracks, except near terminals, and seldom can one of them be turned over to the section hands for a full shift. Actually, considering the inevitable breaks to let trains pass, and deducting the crews' traveling time to and from the working area, men and equipment normally put in no more than 5½ to 6 hours of the 8-hour day. Under such circumstances, smaller units that reduce the investment are preferred.

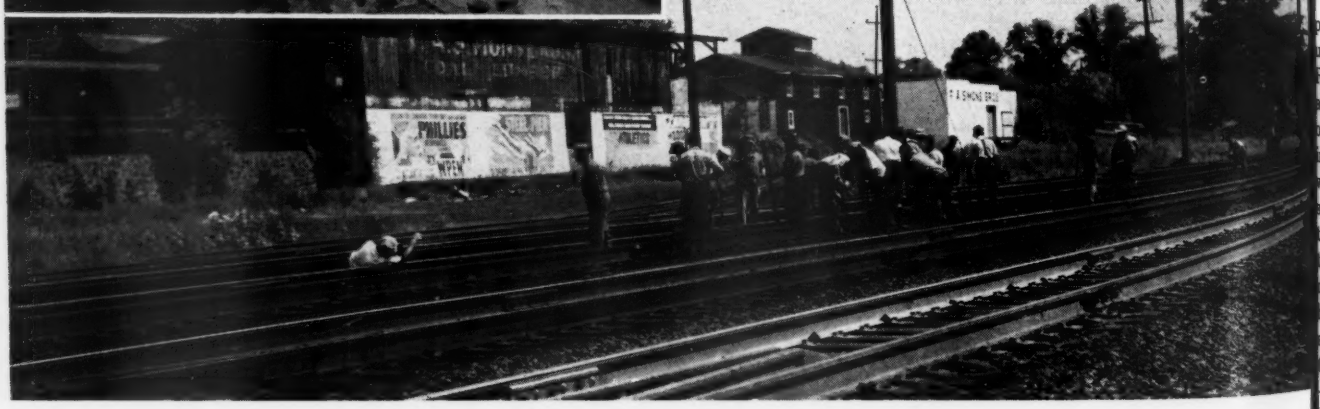
A smaller machine was therefore introduced with some changes in design as a result of the experience gained during the original models' first season on the job. The first of the new 16-tool units went into service west of Chicago on the Chicago & North Western Railway in 1951 and gave such a good account of itself that others were purchased by various lines as fast as they became available. Now, though only in its third year, the McWilliams tamper is being used on fifteen railroads in the United States and Canada.

The machine's principal components are a tamping head, which is mounted across the front of a steel chassis, and an air compressor at the rear. The head is divided, with each half carrying eight tampers centered over one rail and arranged in pairs. The tools that constitute a pair are opposed and spaced just far enough apart to clear the tie between them when they make their downward strokes. Four of the group work outside the rail and four inside, and all are guided in their descent so that they tamp directly under the rail, for a distance of 15 inches on the outer side and 12 inches on the inner side.

Each set of eight tampers is lowered and raised by an air cylinder, and the two groups can be operated together or separately, thus making it possible to tamp under either rail, alone. In fact, the main reason for the divided head is to facilitate tamping at rail joints only. Rails of standard length—39 feet—are staggered with respect to each other; that is, the joint of one falls opposite the center of its companion so that the space between joints is 19½ feet.

At the points where rail sections meet, train wheels have a tendency to pound a little and depress the ballast immediately surrounding those spots. Hence it is often desirable to "spot tamp" two or three or more ties on both sides of a joint. With the divided head, the half on the side where the joint is located can be used while the other half remains idle. This means, of course, that the two groups of tools are used alternately. In a similar manner, low spots that occasionally develop at other places under only one rail can be brought up to grade. The twin construction also facilitates the work of tamping crooked ties that are sometimes encountered. This is done by tamping one end with half of the head and then moving the machine so that the other end can be tamped with the tools on that side.

The tampers are connected to their crossheads by individual push rods that are spring loaded. The springs give each tool independent action, and if one gets through before the others, or if one or more become stuck or inoperative for any reason, the remaining units are not affected. This method of mounting prevents overtamping or crushing the ballast where the depth of the material varies and also protects the tamping tools and bars against breakage. With the weight of the head, plus the force obtainable from the air cylinder, it is possible to bring to bear at each tool a controlled maximum pressure of 700 pounds



SIGHTING FOR RAISE

When track is being resurfaced, it is raised from 2 to 8 inches, the amount depending upon the size of the ballast and other factors. The rails are jacked up the requisite amount ahead of the tamping machine. A member of the gang, often the foreman, sets a telescopic glass on a rail at the height of the raise and sights on a board laid across the track several hundred feet away. Upon signal from the sighter, jacks at intermediate points are operated until the entire stretch under observation is brought up to grade. To help hold it there until it is finish-tamped, ballast is sometimes worked under a few ties along the section. Crude surveying devices such as the one pictured in the close-up at the left have been standard equipment for the sighting operation ever since track maintenance was started and continue to do the job satisfactorily.

FRONT AND REAR UNITS OF SURFACING SPREAD

In track maintenance, air power performs many services other than tamping. Leading a quarter-mile train of human and mechanical workers on the Norfolk & Western Railway last spring was a crew (left) using pneumatic forks to loosen the cemented ballast between ties so that it could be removed and cleaned mechanically. Bringing up the rear was the man shown at the right driving spikes with a pneumatic hammer in new ties that had been put in place of worn or rotted ones. In both cases, operating air came from Ingersoll-Rand wheel-mounted compressors.

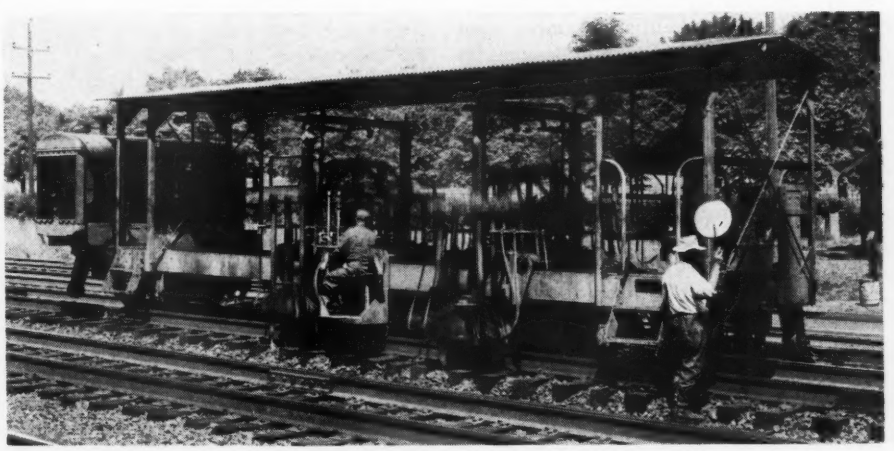
The tamping tools are of the latest MT-4 Type made by Ingersoll-Rand Company for conventional manual operation. The only change necessary to adapt them for mechanical service is to substitute a mounting plate for the conventional backhead handle.

The tamping bars or steels are also standard: 24 inches long and from 5/8 to 1 1/8 inches in section. The flared flat tip is normally 4 inches wide, never more than 5 inches. Because only the bars descend into the ballast, fitting into the available space between the ties does not create the problem presented by some other types of machines that have much bulkier tamping members. As the bars are driven into the ballast under the repetitive impacts of around 2000 piston blows per minute they both vibrate and compact the material. The number of times the tools are lifted out of the ballast and reinserted at each tie varies according to conditions and is controlled by the operator. In most cases, three insertions serve to pack ballast solidly under the full desired bearing area.

The McWilliams tamper is entirely air powered, including propulsion at speeds up to 25 miles per hour by an Ingersoll-Rand air motor. All controls are easily accessible to the operator, who sits on one side immediately back of the tamping head where he has a good view of the working tools. By visual gauging he spots the head directly over the tie to be tamped, and movement from tie to tie takes only about two seconds. When the car reaches the tamping position, it is held securely by air brakes. Lowering and raising of the tamping head is controlled by two levers—one for each half—that respond to fingertip pressure. They are close enough together to be worked by the fingers of one hand.

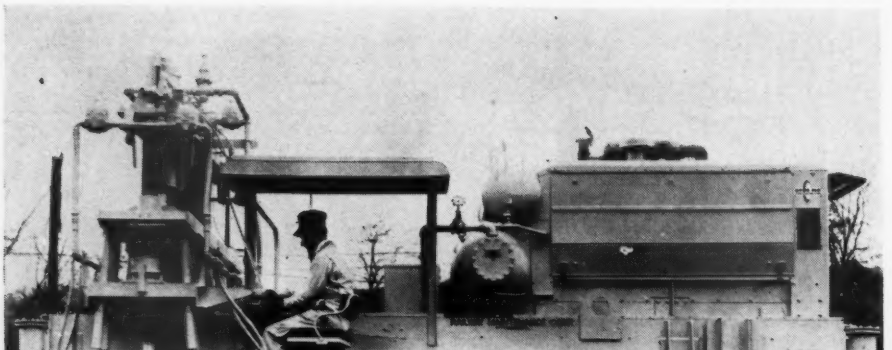
Compressed air is provided by an Ingersoll-Rand diesel-driven Gyro-Flo rotary compressor of 315-cfm capacity. Its output is ample for the service because air is used for only one purpose at a time. For example, when the tamping head is lifted, the air supply to the tools is automatically cut off, and vice versa. In addition to operating the machine, the compressor can also furnish air through hose connections for running spike drivers and hand-held tampers at switches or other locations beyond the reach of the tools on the machine. This makes the McWilliams multiple tamper the only one that can supply power for work other than gang tamping.

The compressor is in the clear on both sides and one end to facilitate servicing it. The car runs on 20-inch flanged steel wheels, is 20 feet long, 8 1/2 feet high and weighs 24,500 pounds. Its fuel tank holds 50 gallons. To remove it from the track there are air jacks at each corner that raise it while rails are slid transversely under small cross wheels. The car is then moved by operating a ratchet with a bar. It can be set off alongside the track in as little as one minute. When the compressor has been shut down and all air exhausted from the receiver the brakes automatically lock, so the machine can't be moved from its trackside parking place by unauthorized persons.



FIRST MODEL MULTIPLE TAMPER

The original Railway Maintenance Corporation machine built in 1950 had two carriages, each mounting sixteen tampers. Both carriages are shown in action, but the operator of the one on the right is on the other side of the machine and out of view. Eleven of these units were put in service on the Pennsylvania Railroad, where the 4-track main line is favorable to their use. In 1951 the smaller 16-tool unit was brought out and is now standard.



THE WEIGHT IS WHERE IT BELONGS

One of the leading advantages of this tamper is attributable to the fact that the tamping head is forward of the front axle, as this illustration shows. The entire weight of the machine consequently rests on track that has already been tamped. This picture also affords a broadside view of the 315-cfm Gyro-Flo compressor and shows that it is accessible from three sides for servicing and maintenance. It can be readily removed for other work where tamping is not done in winter.

Track work, as already pointed out, is indispensable for keeping a railroad functioning smoothly. There are two general types of track maintenance, heavy and light. The first calls for periodical complete rehabilitation of the roadbed, including replacement of bad ties. It requires from 65 to 85 men, depending upon the extent to which the operations are mechanized and the number of tie removals. The men are spread out over a stretch of several hundred yards in various groups, each performing its particular task. The whole job must be well organized, for if one segment in the chain slows down or fails to function all the links behind it will stop moving.

Heavy maintenance is carried on in northern latitudes from April to November or December, and during the inoperative season the equipment is overhauled. But a McWilliams tamper need not be entirely idle even then because its air compressor, merely by running nuts off of four retaining bolts, can be removed and assigned to some other service that needs air power. Southern railroads conduct heavy maintenance the year round, except during rainy periods.

Light maintenance, as the name implies, involves smoothing out irregularities in the track surface and does not involve replacing ties or cleaning ballast. Most dips in track develop at rail joints but are occasionally found elsewhere. Regardless of their location and whether they affect one or both rails, they can be readily tamped with the machine because of its divided head.

It is the practice when resurfacing to jack up the track a few rail lengths at a time so that the ballast can be tamped under the ties. This "raise," as it is termed, may be as much as 8 inches, but is usually 5 inches or less. The size of the ballast used has a bearing on the extent of the raise, and the present tendency is towards smaller ballast than was formerly utilized. The prevailing range is from ¾ inch to 3 inches, with 1½ inches a fair average. Each time a track is resurfaced it is built up higher than it was before, and there are sections of old lines where the rails rest on a cushion 2 or 3 feet deep. It sometimes becomes necessary to lower such tracks, especially in tunnels or on their approaches and at grade crossings in urban districts.

The sequence of operations followed on a heavy maintenance job and the equipment employed varies with the practices and preferences of those in charge, but the result in all cases is essentially the same. In the lead are often four or five men with pneumatic forks operated with air supplied by a rail-car compressor. They loosen the ballast so that it can be more easily removed for cleaning. This is necessary because ballast that has not been reworked for several years is frequently somewhat cemented by foreign materials. These may include dirt that has worked up from the soil below or been blown in, as well as coal dust and chemicals that have fallen from cars that carried them. Wind-blown dust is so great a problem to some western roads that conventional snow fences are erected in places to curb it.

After being loosened, the ballast must be removed from the cribs between the ties, cleaned and returned to the track area. There are several types of machines that do these jobs. Spikes must be pulled from worn, rotted or split ties and the latter replaced with sound ones. Removal can be accomplished either by a machine or by up to four laborers with picks or tongs. Rails are commonly spiked to the renewal ties with a pneumatic hammer designed for that purpose. Regardless of how much the operations mentioned in this paragraph are mechanized, a certain amount of handling of ballast by men with hand forks is inevitable. Laborers are also still needed in most cases to distribute ballast that is added to make up for the loss of bulk during the cleaning of old ballast and to build the roadbed up to the new track level established by the raise.

The rails are brought up to the new elevation either by a power jack and hand tamping of a sufficient number of ties to support the track or by multiple hand jacks. Inasmuch as the tamping head is well forward of the front axle, the McWilliams machine always rests on track that has been finish-tamped. The head can therefore work right up to the hand jacks without imposing any additional load on them, and the action of the tamping bars will raise swinging ties and preclude the necessity of nipping at the tampers; that is, holding ties up to the rails. A small crew may follow to "dress" the track; that is, to tidy up by forking stray pieces of ballast back where they should be and by trimming the edges of the ballast heap into neat lines. Finally one or more men will split the old ties left alongside the track, put them in piles, pour on kerosene and apply a match.

These diversified and ramified operations require a lot of manpower and yet one of the key tasks, the actual tamping of ballast under the ties, is performed by just one man and an ingenious machine. When it is considered that there are about 3000 ties per mile of track, each of which must receive the same careful attention, that fact seems remarkable. The amount of track that can be "put up," as the railroad man says, in a day with one McWilliams tamper varies according to the height of the raise, the size and character of the ballast, the organization and experience of the crew and other factors. From 300 to 350 feet per hour is probably a fair average, although up to 400-500 feet may be reached under favorable conditions. The volume of work it does is, of course, important in this practical world, and the first units introduced had to be sold on the basis of economy. Actually, however, the Railway Maintenance Corporation believes the quality of the work done by the multiple tamper is even more worthy of consideration. It does a superlative job because it has all the desirable features of individual-tool tamping and virtually none of its shortcomings.

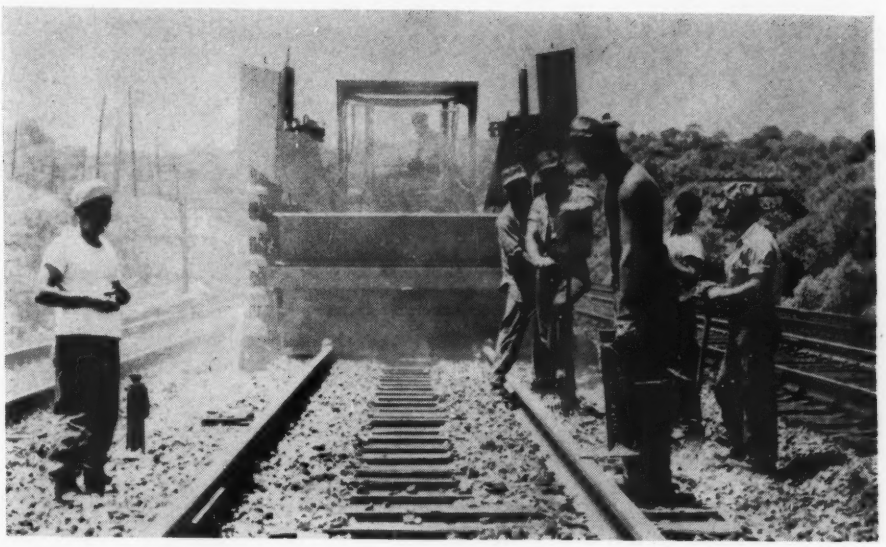
As R.M. Jenner, vice-president and sales manager of RMC puts it, "Older railroad men recall a time when the average section hand did a bang-up job with his fork or power tamper and the fore-

man, who invariably lived along the railway, took so much pride in the work he supervised that he usually walked out on the right of way after his evening meal to look it over with satisfaction. But, times and personnel have changed, and now it is just about impossible to find men that like their work that well."

But the 16-tool robot does as good a job as the best manual tampers ever did and does it more consistently. Cams guide each tool in the same path on every downward stroke, something the most adept workman could never achieve. The path has been planned to do the job in the best possible way. The tool starts out at an angle of 30° from the vertical, and as the tamping bar enters the ballast the angle increases and the bar turns under the edge of the tie in front of it. At the same time, the bar of the tool on the other side of the tie does likewise. The two approach each other on the same angle and stop with their tips just 2½ inches apart.

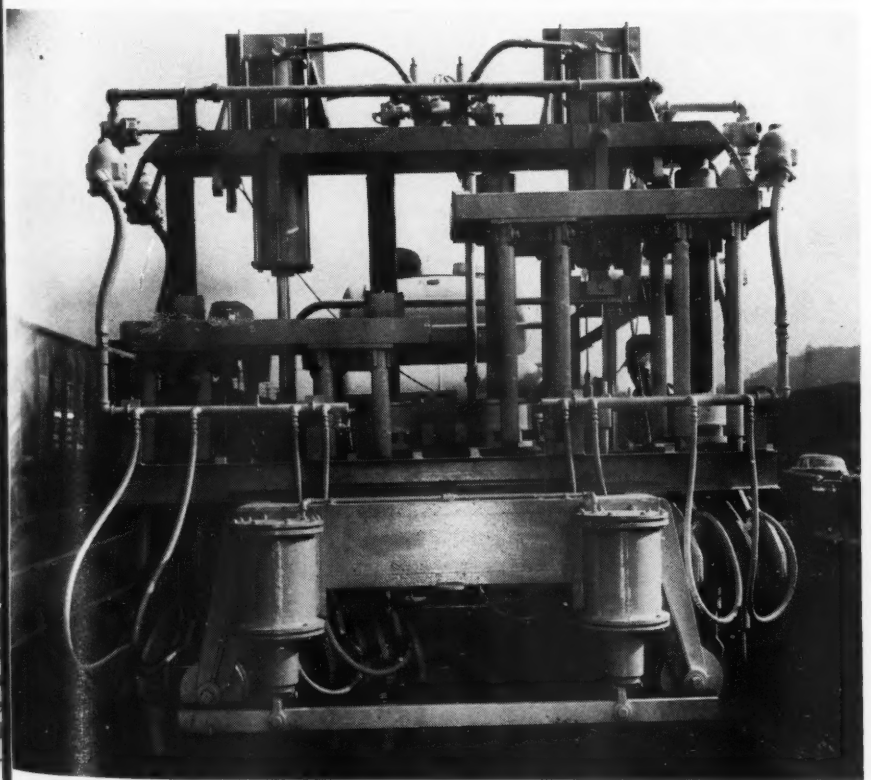
To get the best results, it has been found that the bars should finish their strokes about 1½ inches below the bottom of the tie, and means are provided to bring this about regardless of the height of the rails on which the car is running. Rails on many lines vary in weight from 110 to 150 pounds per yard and differ in height by as much as 1 9/16 inches. However, when the machine is moved from rails of one height to those of another, the tamping head may be quickly lowered or raised merely by adjusting locknuts to keep the working depth of the tools uniform.

Such undeviating accuracy hour after hour is beyond human capacity; one man could never hold the tamper the same way throughout a day, and it is impossible to conceive of sixteen men working in unison. Yet on this machine the sixteen tools, held in inflexible steel grips, never vary even slightly. Furthermore, the pneumatic muscles that drive them never tire; the final thrust in the evening has the same force as the first one on the shift.



BALLAST DISTRIBUTOR

This is the latest of the various machines for track work conceived by J. B. McWilliams and his associates and manufactured by the Pittsburgh firm he heads. It distributes the correct amount of ballast for a track raise of any height, placing it both inside and outside the rails in position for tamping. It operates at a speed of 800 to 1200 feet per hour.



HEAD-ON VIEW

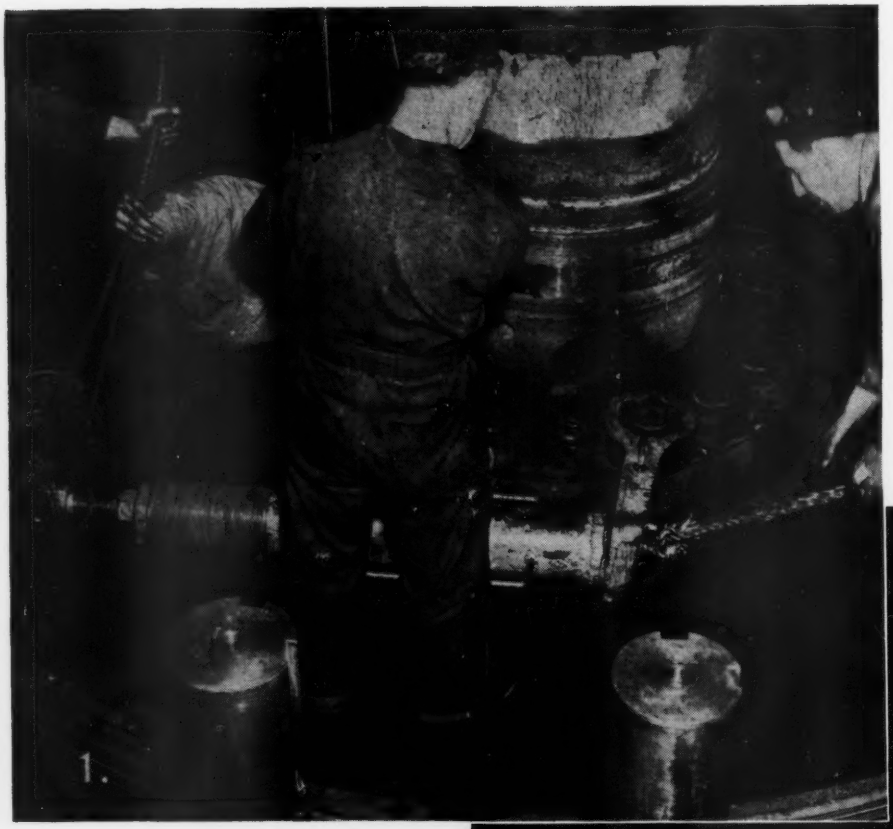
The left half of the divided tamping head is down, the right half up. The vertically disposed actuating air cylinders are at the top. The cylinders at the bottom-front are air jacks that raise the machine when it is to be set off the track. This permits slipping transverse rails under the small cross wheels just outside each rail. The rear end is similarly equipped.

Still another advantage follows as a consequence of the tampers traveling in the same path all the time, and that is a reduction in wear considerably below that of hand-directed tools. This surprising fact came to light when machines were torn down for overhaul after operating all season. A factor that contributes to their durability is that air-line oilers lubricate them adequately all the time they are running.

The multiple tamper is only one of several mechanical aids developed by RMC for track work. Mr. McWilliams organized the company 30 years ago when he conceived the idea of a device for cleaning ballast while in the employ of the Pennsylvania Railroad. That machine, the Mole, was designed to clean ballast between tracks and on the shoulders without interfering with the operation of trains. Next came the tractor-mounted McWilliams Super-Mole that is based on the same principle but has greater speed and capacity.

Then there is the McWilliams crib cleaner which similarly treats ballast that fills the cribs between the ties. His latest creation, the ballast distributor, which was introduced after the multiple tamper, spreads ballast over a prescribed distance and to a uniform controlled depth both inside and outside the rails. This crib preparation is said to add materially to the productivity of the multiple tamper.

Striking Savings Made with Large Impactool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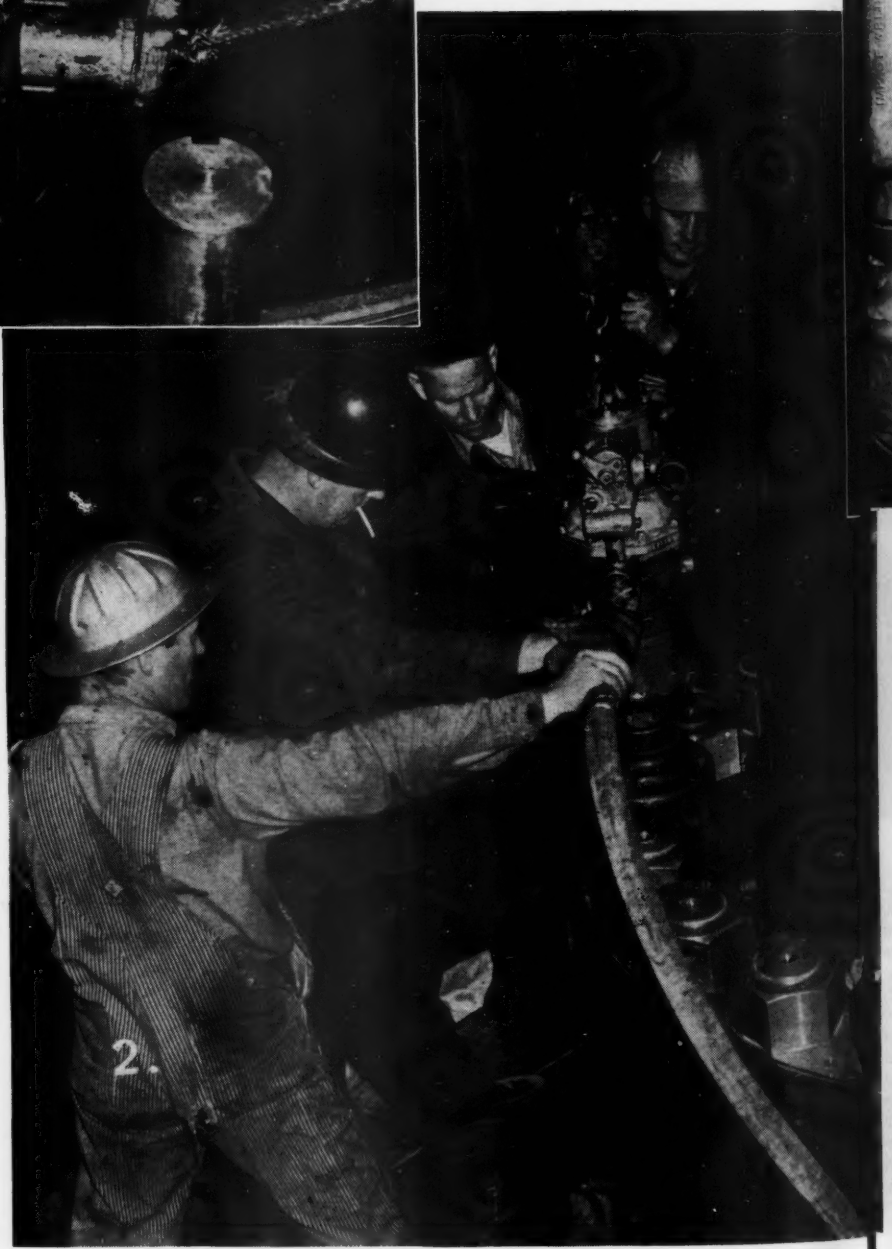
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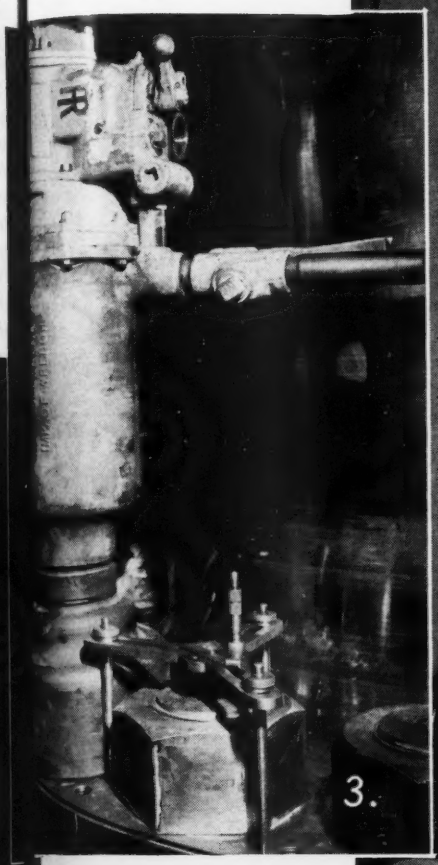
ACCOMPANYING pictures strikingly portray the difference between removing and applying nuts of large size with a hand wrench, on the one hand, and with an air-powered Impactool, on the other. They were taken in Hoover Dam powerhouse on the Colorado River, some while the hydroelectric generators were being installed and others later on while they were being overhauled.

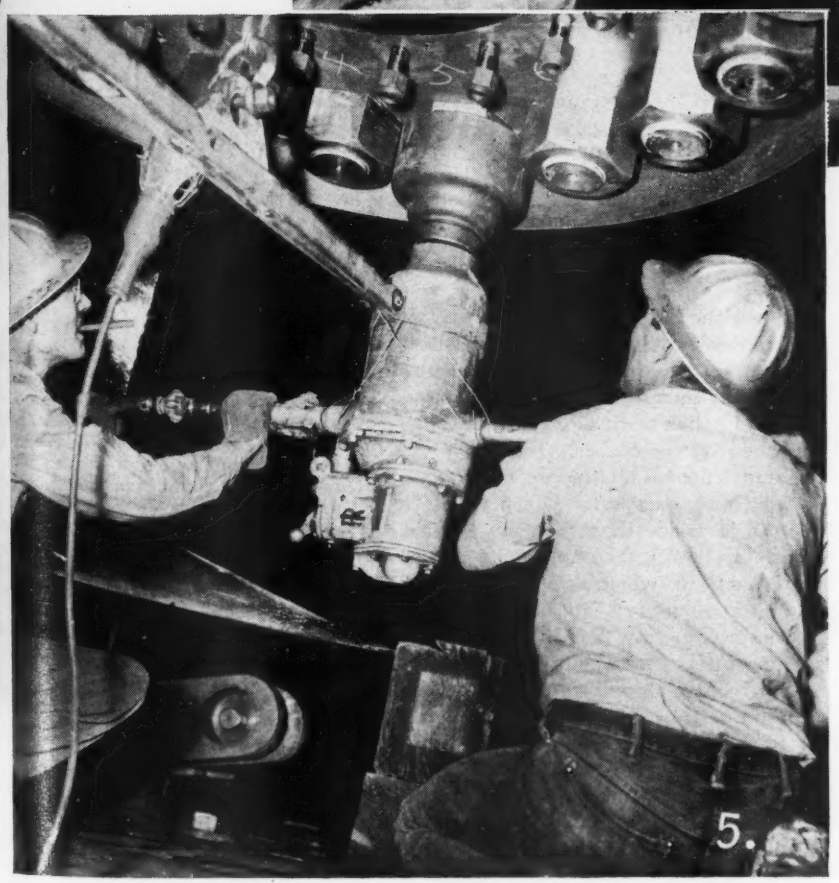
The Impactool used is an Ingersoll-Rand Size 588. It weighs 215 pounds without a socket and is 26 5/8 inches long. The tool converts the power from a conventional Multi-Vane air motor into rotary impacts. When supplied with air at 90 psi pressure it applies 550 impacts per minute, resulting in a great torque or twisting effect which, however, is not transmitted to the operators through the handles of the tool.

The operations shown consisted in taking off and replacing hexagonal nuts on coupling bolts of drive shafts connecting turbines and generators of 70,000-hp and 115,000-hp units. In the case of the latter, fifty-four 4 3/4-inch (thread size) nuts were removed and reapplied to stud bolts 21 inches long. By the former method, this necessitated striking a large wrench with a 450-pound swinging battering ram both when loosening and tightening the nuts. It took a total of approximately 200 man-hours to remove and replace the 54 stud bolts. With the Impactool the same work was accomplished in 35 man-hours, resulting in a saving of 165 man-hours.

At the average wage rate of $2.15 per hour being paid, this amounted to a reduction of $354.75 in labor charges alone, or more than 20 percent of the cost of the tool.

In addition, there was a far greater but not precisely determinable reduction in idle generator time. The importance of this may be appreciated when it is realized that each unit produces around $300 worth of current per hour when on the line.





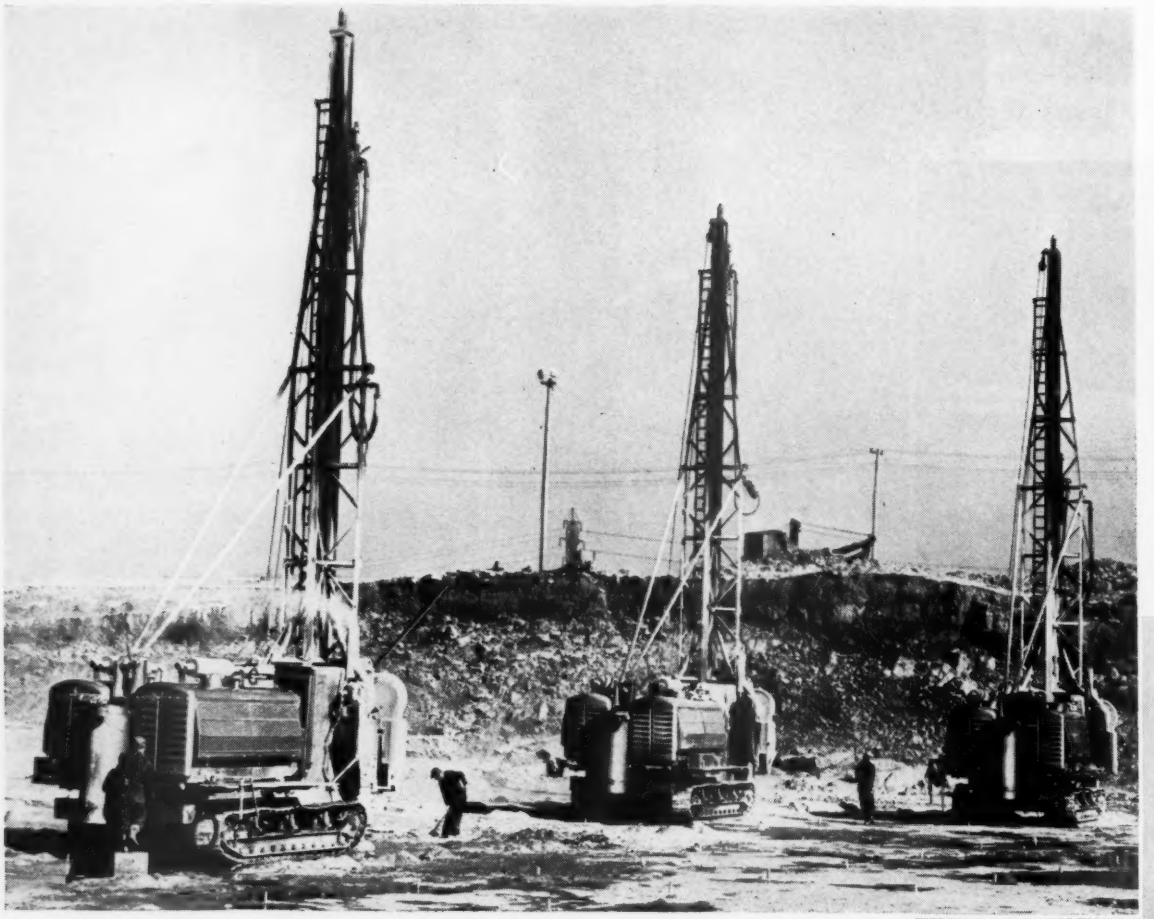
1 **OLD WAY.** Loosening a nut from a 4¾-inch bolt by striking it with a swinging battering ram 6½ inches in diameter, 48 inches long and weighing 450 pounds.

2 **NEW WAY.** Tightening a nut of the same size with a Size 588 Impactool suspended by tackle. The nuts are 7⅛ inches across the flats.

3 **MEASURING STRETCH.** Nuts were tightened until the bolts showed a stretch of at least 0.012 inch. Shown in the foreground of this close-up is the tripod and micrometer depth gauge used for measuring the stretch.

4 **LOWERING BOLT.** One of the hub bolts around the runner of the turbine shown as it is being lowered into place. Another one is hanging from a rope.

5 **WORKING UPWARD.** Putting a nut on the lower end of one of the hub bolts on the underside of the runner. The Impactool was suspended from a cable hanging down through the opening in the center of the drive shaft.



More Canadian Kilowatts at Niagara

Part 2

Description of Work on 51-foot-diameter Tunnels and 200-foot-wide Canal

H. R. Rice

WITH two groups of contractors at work on the five sections of the tunnels, and with each section superintendent being at least partly autonomous in driving his stretch, it is inevitable that there should be considerable difference in the methods followed, despite the high degree of coöperation and interchange of information among Ontario Hydro and the contractors. In covering the operations, an effort will be made to describe average or typical conditions and procedures and to discuss only those variations from standard practice that seem to be of more than ordinary interest.

The Commission is furnishing such materials as concrete and steel and providing engineering control. It also keeps close check on quantities and, in general, satisfies itself through continual inspection that its specifications are being met. The contractors' staffs are responsible for their own designs, methods, purchase and supply of equipment and consumable stores and for supervising excavation and other work along the lines established by the owner.

Tunnel access shafts are circular in section, and, except for No. 5 which is 30 feet in inside diameter, are 26 feet across. In depth, they differ with the invert elevation, which is 330 feet below ground at Shaft 5, near the intake end, and approximately 210 feet at Shaft 4 at the outlet. These depths, however, do not include skip and loading pockets and sumps that are below invert level. Shafts were collared to bedrock by sinking either steel or concrete caissons, the sections in rock being at least partially supported usually with concrete rings on 6-foot centers. The greatest depth of overburden was encountered at Shaft 1 where a glacial deposit, consisting of a mixture of silt, wet clay and wet running sand, reached a thickness of 115 feet.

Two 10-cubic-yard skips are operated

DRILLING IN CANAL

After from 20 to 30 feet of overburden had been removed, the remaining 40 to 50 feet of rock to be excavated was drilled and blasted in two lifts. At the downstream end the top lift was drilled with wagon drills, and the picture directly above shows five Ingersoll-Rand units of this type at work. They put down approximately 2-inch-diameter holes around 20 feet deep and spaced them on a 5x6-foot pattern. Elsewhere on the canal excavating was done with five large drills, including three Ingersoll-Rand Quarrymasters (top-left). These machines drilled 6¼- and 6¾-inch holes spaced from 12 to 15 feet apart and ranging from 30 to 45 feet in depth.

EXCAVATING CANAL

A section of the 2¼-mile canal while excavating was in progress. This man-made waterway will be 200 feet wide and 70 feet deep and calls for the removal of about 16 million cubic yards, mostly rock. During the height of the operation seven power shovels, with buckets up to 6-yard in capacity, loaded into 90 trucks that hauled from 20,000 to 25,000 cubic yards per day to disposal areas.

LOADING MUCK IN TUNNEL

A Northwest electric-powered shovel loading broken rock into a 14-yard diesel dump truck in one of the huge bores. Normally the shovel has a 2½-yard bucket, but by shortening the dipper stick to 13 feet so that it could work in the restricted space it was made to handle a 3½-yard bucket.

in counterbalance in each shaft and hoist upwards of 3000 cubic yards per 24-hour day, or about 6800 tons, the maximum speed for the relatively short lifts averaging 400 feet per minute. At Shafts 1 and 2 the skip hoists are 72x42-inch parallel double-drum single-reduction units, while their cage hoists, of similar design, are 60x48-inch units. They are powered by 500-hp motors and handle the skips with 2-part lines and the cages with 5-part lines. All the hoists at shafts 3, 4 and 5 are 96-inch double-drum units that operate the skips and cages in counterbalance with 450- and 300-hp motors, respectively, and with single lines. Cages are of typical 9x22-foot size, sufficiently large to accommodate any truck or other vehicles used in the tunnels to transport materials and supplies.

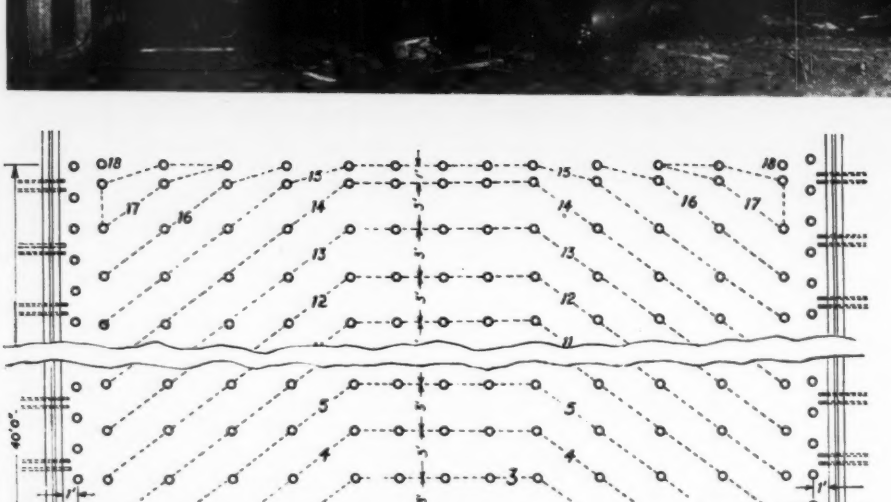
To meet ventilation requirements, which are heavy because of the rapidity with which the tunnels are being advanced, each shaft has two 4½-foot-diameter vent pipes connected to two fans, each rated at 75,000 cfm and powered by a 300-hp motor. The fans are of the reversible type and blow fresh air into the headings except for a short period after blasting, when they exhaust smoke and gas.

The compressor plant at each of the five shafts supplies about 5000 cfm of free air. That at Shaft 1, a typical example, consists of two 1718-cfm units and two 1080-cfm machines, making a total capacity of 5600 cfm. Stationed at shafts 3, 4 and 5 are smaller, 750-cfm semiportable units mounted on skids. These require no foundation other than the concrete floor slab of the compressor house and can therefore be quickly moved from one shaft to another, as the working schedule dictates.

Rock drills consume slightly more than half of the compressed air available, the remainder being used to perform a multiplicity of services, including the operation of loading gates at skip pockets and at surface bins. The air is piped to the tunnel faces through 6-inch lines suspended from the steel supporting sets. Also provided at each shaft are facilities for the prompt repair of all types of equipment, and a great deal of emphasis is placed on preventive maintenance or servicing of trucks, shovels, rock drills, etc., directly employed on the job.

The tunnels are fully circular in finished cross section and are excavated to a diameter of 51 feet to the "B" line. That is what is known as the "pay line," all areas lying outside of it being considered overbreak. Six inches inside of it is a second control line—the "A" or "minimum concrete line." Under ideal conditions the perimeter of the tunnel excavation coincides with the "B" line, which means the removal of 75¼ cubic yards per lineal foot of advance, measured in place.

As tunneling progresses, steel arch sets, composed of prefabricated 8-inch H-beams, are placed at intervals of 4 feet the full length of the bores. Each set or



DRILLING TUNNEL BENCH

After excavating the top heading of the 51-foot-diameter tunnels, the invert or bench is drilled with the carriage pictured above. The rig consists of two horizontal beams spanning the full bench and is suspended from trolley rails. It is moved ahead by an Ingersoll-Rand tugger air hoist, with two smaller ones serving as snubbers pulling in the opposite direction. On the carriage are seventeen DA-35 drifter drills—five power-feed units at each end mounted on a quarry bar and seven in the center on towers for putting down the deeper holes. The diagram shows the plan and elevation of the drilling pattern. The numbers indicate the order of firing the holes with millisecond-delay detonators.

"rib" is brought underground in four pieces, which are butt-bolted together at the time of erection. The ribs are supported at both ends by wall plates each made up of two 10-inch I-beams laid side by side on 12x12-inch timber posts also on 4-foot centers. The bottom faces of the wall plates are 1 foot above the springing line.

Bracing between the steel sets and between the posts supporting the wall plates consists of 4x6-inch timber spacers and 6x6-inch collar braces, respectively. Where required, 6x6-inch stringers and lagging are placed between and above the ribs, and the whole structure is blocked and wedged in a planned sequence from both sides of the tunnel simultaneously. Then it is further stiffened by clipping steel channel lagging to the flanges of adjacent sets.

All the tunnel sections are now being advanced by driving a top heading and by benching with vertical holes to complete the excavation to invert grade. However, it may be of interest to touch briefly upon the method followed by the contractor on Sections 1 and 2 at the beginning of the project. He drilled a full heading from arch to invert, leaving a narrow berm on each side to be removed later. For this work he used a 2-part drill jumbo divided horizontally so that the upper section rode on gantry rails laid on top of the berms and the lower one on rails placed on the bottom. The crosscuts of the two shafts involved were established at invert elevation.

At the start, weekly progress in two headings driven from one of the two shafts was slightly more than 200 feet. In September-October, 1952, however, it was decided to adopt the top heading-and-bench method as introduced by the other contractor largely because it was difficult to clean and scale the large face exposed and, on account of the great height from floor to roof, to handle steel and timber. This changeover was effected in both sections in November, and within two months the crews at Shaft 2 had set a top-heading record with an advance of 469 feet in the north and south headings of Tunnel No. 1 during the 6-day week ended January 9, 1953.

(Described in June, 1953, issue.) Meantime the mark has been surpassed twice, the last time when Shaft 2 crew pushed ahead 568 feet during the week ending June 26, 1953:

Rounds drilled and blasted	33
Average time, round	5 hr 5 min
Advance, round	17.2 ft
Average daily advance	81.1 ft
Drills used	22
Total footage drilled	111,876
Average footage, round	3,572
Rock excavated	26,696 cu yds
Average explosives, cu yd	2.56 lb
Ribs placed and lagged	135
Tons steel placed	371
Ribs placed in 24 hrs.	22 max
Timber blocking placed	80,536 fm

The top heading includes the upper semicircle of the complete excavation plus a segment of about 3 feet, giving it a total height of 29 feet and calling for the removal of 44 cubic yards per lineal foot, or about 60 percent of the full face. It presents a typical pattern used by one of the contractors rather than universal practice and varies from shaft to shaft and from heading to heading with changes in rock-breaking characteristics. Whenever possible, two faces are pushed forward from one shaft in opposite directions at the same time, drilling and clearing proceeding alternately. Shaft spacing limits the maximum haulage distance to the dumping point at the crosscut to about 3100 feet.

The drill sections of the carriages have three decks so that drilling can be carried out from four levels. Each heading has its own jumbo equipped with seventeen drifters each mounted on a hydraulically actuated jib that makes it possible to move the drill quickly and to set it in widely variable positions within the reach of the jib. One of the contractors has standardized on a pneumatic screw-feed drifter that permits a 4-foot steel change, and the other on an air-powered chain-feed type that allows an 8-foot change.

There are three machines on the top deck; four on each of the second and third platforms; and six inverted from the underside of the lower one for drilling knee holes, lifters, and the bottom part of the cut. Each carriage is self-contained—has an air receiver, air and water manifolds, two pneumatic-hydraulic oil pumps for operating the jibs, floodlights and all other necessary tools and equipment, including spare drifters.

The other section of the jumbo is used to place the steel sets and timbers following drilling and is provided with air-powered tugger hoists, impact wrenches and other essential tools. In putting a rib in position, the four members are bolted together with the two legs each resting in a template, the top joint being made after the rib is hoisted into place. Timbering is then completed, a supply of blocking, wedges, and lagging for the purpose being carried on the jumbo. The latter is mounted on four sets of double-flanged tandem wheels running on 80-pound gantry rails laid in 15-inch channels.

Hollow, round drill steel, 1⅛ inches in section and with lugged shanks for detachable bits, serves throughout. With regard to the latter, one contractor has standardized on 4-wing tungsten-carbide bits with a 2-inch starting gauge that is reduced gradually to 1⅝ inches for the longest steel used. Average bit life is 600 feet of penetration. One routine procedure that has proved of value to this contractor is the removal of all shanks and bits to the surface between rounds. There they are carefully checked: bits are changed or ground where necessary and shanks cleaned and examined for fatigue cracks and other possible defects. As a result, every drilling cycle is begun with a complete set in a condition that minimizes lost time through bit or shank failure. On the other contract, one-pass steel bits are standard in the dolomite and shales in the upper part of the face and detachable tungsten-carbide bits in the underlying sandstones.

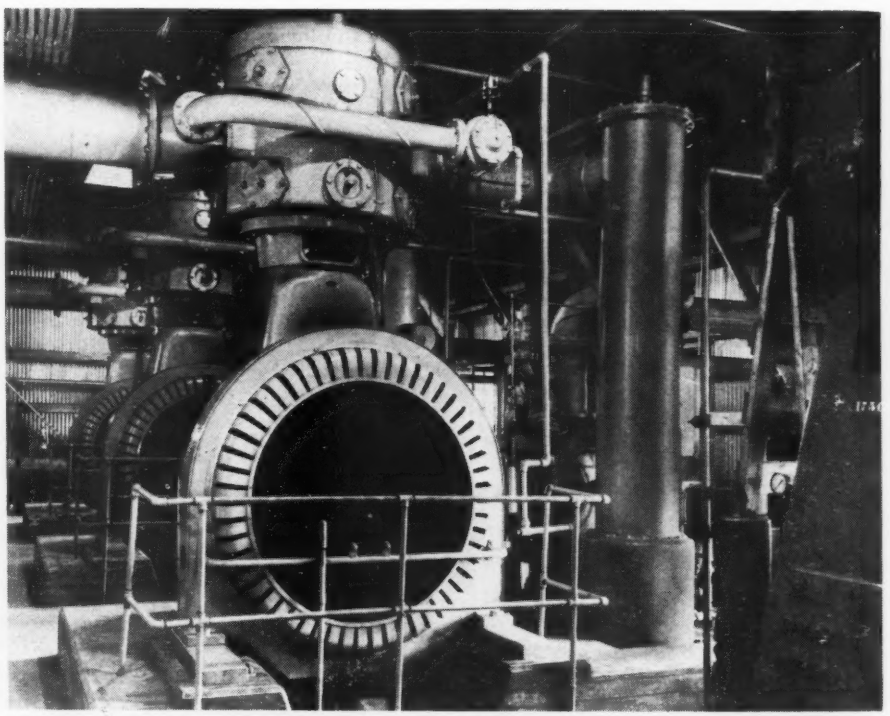
A typical drilling crew consists of 37 men—seventeen drillers, seventeen helpers and three leading hands—and a shift at each shaft numbers around 110, not including truck drivers, shovel operators and others that fall under the supervision of the mechanical department.

The drilling and blasting pattern is the result of considerable experience on this job and calls for 0.52 pound of explosives per foot of hole. It has been found to be the most effective one, particularly by reason of the fact that the material brought down can be easily handled by the shovels. Cartridges are 1⅛x8 inches in size and both the strength and kind of powder used vary. Generally, however, 70 percent ammonium gelignite or semi-gel serves in the cut and 40 percent gelignite for squaring up.

Charges are detonated in delays from 0 to 15 and are connected to a bus-wire system which, in turn, is connected to a special blasting circuit. Lifters are, as a rule, double-primed. As a safety measure before loading operations are begun, all power for lighting is disconnected from the jumbo to obviate premature firing by currents straying along the steelwork of the structure. For the same reason, weather forecasts are noted at frequent intervals throughout every day, and no charging is permitted if an electrical storm is imminent.

Broken rock is cleared away by either a diesel or an electric shovel with a rated capacity of 2½ cubic yards. It is provided for work in confined quarters with a shortened boom and dipper stick that permit the use of a 3½-yard bucket. A bulldozer and a tractor-mounted overhead loader do the cleaning up. The shovel loads the spoil into 14-yard diesel dump trucks which haul it to the shaft crosscut and discharge it onto a grizzly over the 10-yard skip-loading or measuring pocket.

At the surface, the skips dump their loads into a 150-cubic-yard bin with air-operated arc gates through which the rock falls into 16-yard semitrailer dump



AIR COMPRESSORS

Some of the great volume of compressed air that performs many indispensable services on the big job is furnished by the three large Canadian Ingersoll-Rand compressors shown here. Three similar but slightly smaller units are installed in the same plant at the downstream end of the work.

trucks and other vehicles for haulage to disposal areas. Average mucking time is approximately four hours for a 16-18 foot round. All diesel trucks, shovels, and other equipment in regular service below ground are provided with exhaust conditioners, and the tunnel atmosphere is checked at regular intervals for noxious gases.

Of more than common interest is the method by which the bench is excavated to invert grade. A special jumbo was developed for this purpose by the Perini-Walsh group and has been adopted as standard in all sections. It is illustrated in an accompanying photograph and in a section showing the drilling pattern. Essentially, the carriage consists of two 18-inch horizontal I-beams set 10 feet apart. Together with its decking and bracing, it is suspended from trolley rails which, in turn, are suspended at the working point from three of the steel ribs to which they can be quickly attached or detached by gravity-cam clips when they have to be moved forward.

Over each beam is fixed a long quarry bar on which the required number of drifters is mounted vertically, there being one machine for each hole in a row. Two rows can be put down from one setting of the jumbo, but present practice calls for only one. Upon completion of a row, the position of the carriage can be quickly changed to drill the next one, the unit being equipped for this purpose with one 7½-hp air-powered tugger hoist and two 2½-hp units, the latter serving as snubbers and to help line up the carriage.

Originally, benching was done considerably ahead of blasting and shoveling and a 5x5-foot drilling pattern was used. However, that resulted in an overly large proportion of big chunks in the spoil and, in addition, it was difficult to control the invert profile. To overcome these disadvantages, the contractors tried putting down a 4-foot hole in the center of each square, and while that procedure produced better muck, it was hard on the lagging overhead and did not correct the problem of the invert profile. The size of the pattern was then successively reduced to 4x4 feet and to the present combination of 3x3 feet and 3x4 feet, as shown.

Drilling bench holes too far ahead of shooting and shoveling caused trouble. As mentioned in the first part of this article, the Grimsby sandstone being penetrated has a number of thin shale parting members that have a tendency to squeeze or flow under pressure. Because some holes were always lost when left too long unblasted, it was decided to put down only the number to be fired in one set, usually fourteen rows. Included in the benching job is the drilling of holes for the insertion of 1½-inch by 5-foot mild-steel bolts to support each of the timber posts on which the wall plates rest. This is done to insure the plates a firm base after the bench is blasted.

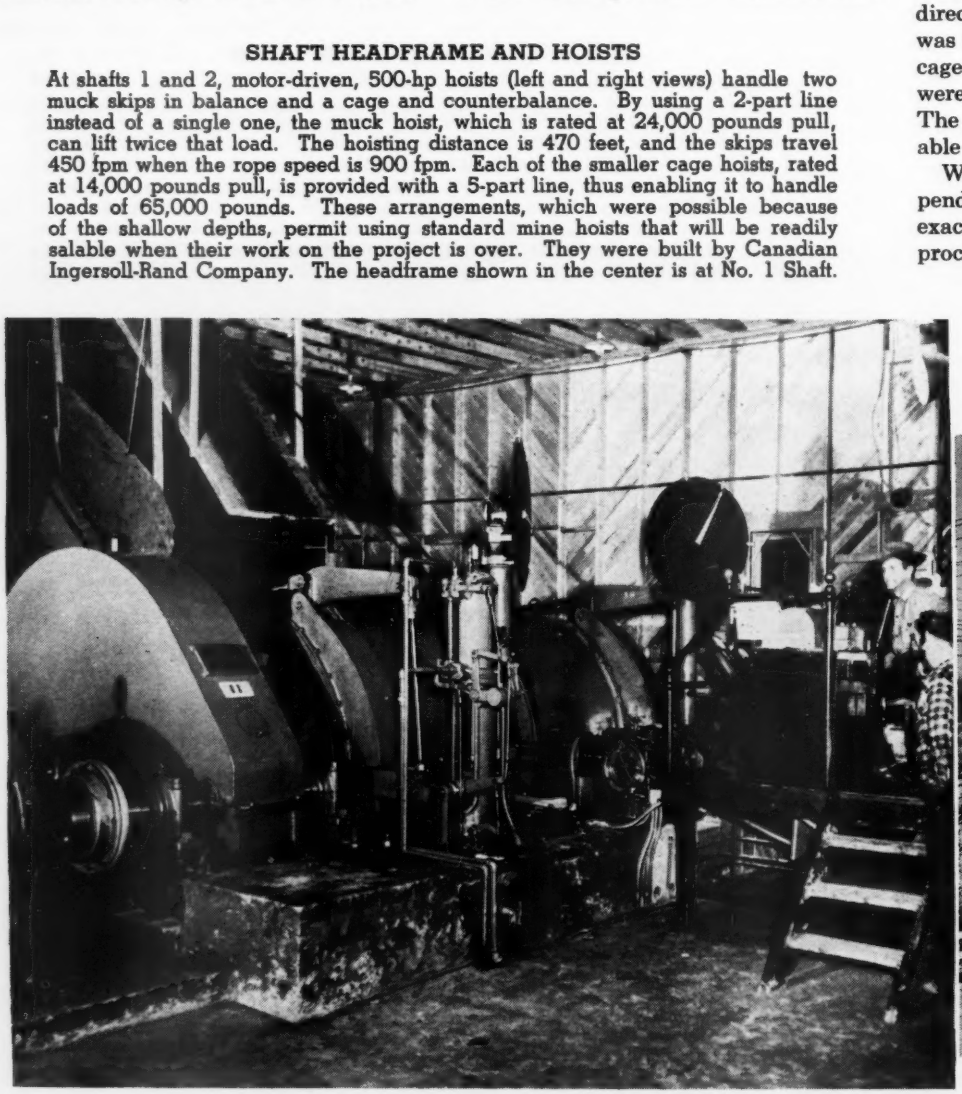
In putting down a set of bench holes, one contractor toes the holes at an angle of 85° from the horizontal, except the final row which is drilled vertically to give a smooth face. Millisecond-delay detonators are used throughout, and the safety regulations enforced in blasting the top heading also apply to the bench. A total of 29 cubic yards is excavated per foot of advance, and the record for this work is held at Shaft 4 where slightly more than 3000 linear feet was excavated in five weeks.

The route of each tunnel is marked on the surface by a series of concrete monuments placed along the center line. Their exact distances from the intake end were established, together with the bearings of the adjacent course to the nearest 0.1 second of arc. At each of the five shafts, using high-precision theodolites reading direct to 1 second of arc, an angle of 90° was turned to pass across the top of the cage compartment in which two wires were hung, giving a base of about 22 feet. The positions of these wires were adjustable through sets of micrometer screws.

When the line of wires was fixed perpendicular to the tunnel course and the exact offset footage had been noted, the procedure was reversed in the shaft cross-

SHAFT HEADFRAME AND HOISTS

At shafts 1 and 2, motor-driven, 500-hp hoists (left and right views) handle two muck skips in balance and a cage and counterbalance. By using a 2-part line instead of a single one, the muck hoist, which is rated at 24,000 pounds pull, can lift twice that load. The hoisting distance is 470 feet, and the skips travel 450 fpm when the rope speed is 900 fpm. Each of the smaller cage hoists, rated at 14,000 pounds pull, is provided with a 5-part line, thus enabling it to handle loads of 65,000 pounds. These arrangements, which were possible because of the shallow depths, permit using standard mine hoists that will be readily salable when their work on the project is over. They were built by Canadian Ingersoll-Rand Company. The headframe shown in the center is at No. 1 Shaft.



cut and a primary control line set in the tunnel and offset 20 feet from the actual center line. The stations on this primary control line were placed at intervals of about 400 feet. Their positions were determined by measuring from an established point rather than by latitudes and departures.

An important refinement of the system is the use of a graduated brass scale to which is attached a rider from which hangs a plumb bob. The vernier scale can be read directly to 0.001 foot, and the fourth place readily estimated. In transferring a bearing, successive and repetitive readings are taken on the scale, and the plumb-bob rider is set at the calculated mean position. Each station on the primary control line consists essentially of one of these brass scales clamped tight to a steel pin wedged securely in a hole drilled in rock.

From the primary line, a secondary control line is maintained within 100 feet of the face and offset 22 feet 10 inches from the tunnel center line, or 2 feet from one wall plate. Each station on this line consists of a spud driven into a hardwood block wedged between rib flanges. In addition to the distance denoted by the respective stations there is a saw cut every 50 feet along the top edge of the wall plate. The contractors' tunnel engineers operate from this secondary line, the primary line being maintained by the owner. From the secondary line, and from temporary extensions from it, the positions of all steel sets are noted, overbreak is measured and the successive drilling operations are controlled.

Concreting of the twin bores is done in two principal stages after a curb has been placed along each side to serve as a form for the 60° arc sector of the invert paving. The curbs are 24 feet apart and poured in portable steel forms about 600 feet behind the bench excavation. On top of them are laid 80-pound rails for the gantry that lines the invert. But before this is done, the area between the curbs is cleared by a bulldozer and overhead loader and then cleaned thoroughly with blasts of compressed air.

Concrete is delivered from the surface through 9-inch holes drilled to the arch elevation of the tunnel before the top heading is excavated. These are spaced at 350- to 500-foot intervals along the center line, and when each hole reaches its proper depth a short steel sleeve is grouted into the bottom of it. Beneath each opening is erected staging as soon as the top-heading crew has passed by.

Aboveground, a portable diesel powered feeding hopper is spotted over the drill hole closest to the paving operations and into it 10-yard semitrailer trucks dump concrete from the nearer of the Ontario Hydro's two mixing plants. At the bottom of the hole is stationed a receiving gantry which delivers the mix to three 10-yard hoppers mounted on the pouring gantry. The latter is operated by a diesel engine and shuttles between the supply point and the paving screed. Concrete consumption averages 3 cubic yards per lineal foot, and the work normally proceeds at a rate of 30-35 feet or 90-100 cubic yards per hour.

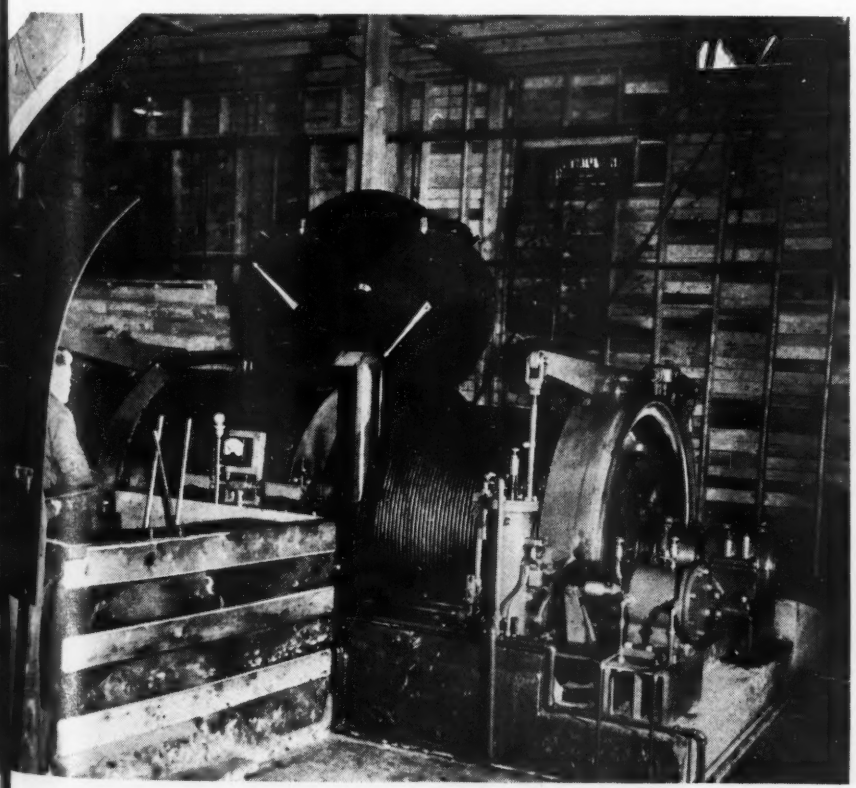
The arch is prepared for concreting by removing some of the steel channel lagging and a considerable quantity of the timber lagging. Then the remaining lagging and the steel ribs, which constitute the only reinforcing, are freed of scale and cleaned with compressed air. The arch forms are of two somewhat similar types and are fabricated in Canada under licences from the patentees in the United States. In general, both consist of 5-foot-long sections fabricated from steel plate and are carried on a truss structure hinged at two points to the upper chord to allow a slight collapse for changing position. At the same time, the top 60° arch sector can be lowered on its jacks. One form permits the concreting of a 50-foot length of arch at one pour; the other a 60-foot length. On curves, wedge sections are placed between the 5-foot sections to make up a form.

Concrete is fed into the tunnel as already described and is received in a 20-yard hopper on a pumping gantry spotted beneath the 9-inch-drill hole. The gantry is equipped with three pumps with a combined capacity of 150 cubic yards per hour. These deliver the material to 8-inch lines that pass through a bulkhead ring in the arch form.

The present schedule calls for filling the 50- or 60-foot section in the course of an 8-hour shift, which amounts to 750 or 900 cubic yards, as the case may be. The concrete is left to set for 8 to 10 hours. During the night shift the form is moved to the next position and everything is made ready to resume pumping on the morning shift. The total amount of concrete required for the 55,835 feet of tunnel is estimated at one million cubic yards, or 18 yards per lineal foot. Concrete plugs are to be placed in the crosscuts at all five shafts.

To permit grouting where needed, there are six or eight holes at different points along the upper semicircle of the arch form for the insertion of pipes into the freshly poured concrete. After the latter has been allowed to set for 28 days the pipes are cleaned out by means of drills which extend some of the holes into the rock. The drills used are operated from a light gantry erected for the purpose. Specifications call for the injection of grout at not more than 100 psi initially, but after a 3-month interval, if considered necessary, more grout is applied under higher pressure.

After the canal site had been cleared of overburden from 20 to 30 feet thick, the rock was removed in two lifts partly because the upper 20-25 feet was in Lockport dolomite unsuited for use as concrete aggregate. Excavating was begun on the downstream side of the crossover (point where the old canal intersects the new one) with 4-inch wagon drills using 2-inch detachable one-pass steel bits as starters and decreasing to 1½-inch gauge at the bottoms of the 20- to 25-foot holes. The drill pattern on most of this work was 5x6 feet, and the holes, loaded with 40 percent gelignite in 1⅛x8-inch car-



tridges, were detonated with millisecond caps in delays from 0 to 11. A berm was left along each wall for removal later with closely spaced blast holes to insure the smoothest possible wall, for the specifications do not include a concrete lining except in the trapezoidal section and in stretches of the crossover.

All the upper lift upstream from the old canal and the entire lower lift were excavated by use of large drills: three percussion machines, equipped with chopping bits tipped with tungsten carbide, and two rotary drills with chilled-steel roller-cone bits. They put down holes 6¼ and 6¾ inches in diameter, respectively, ranging in depth from 30 to 45 feet in the lower lift, depending upon the position of the Gasport-DeCew contact below the drilling floor.

In this work, the drilling pattern varied from 12x12 feet on 30-foot benches to 15x15 feet on higher ones. Gelatine dynamite of 60 and 70 percent strength in the form of 5x16-inch cartridges was "deck-loaded" in the holes along with the detonating fuse that extended all the way to the bottom. The practice was to divide the charge into three lots interspersed with rock screenings 4 to 5 feet deep. Fifty percent of the explosives was placed in the bottom, 30 percent next, and 20 percent on top. Two millisecond-delay caps were attached to the upper end of the fuse before wiring.

Batteries of 400 holes were fired at one time in 0 to 11 delays in a modified "herringbone" sequence. Thus holes in the center of the canal were made to throw their burdens parallel to the cut, and those at the sides in a transverse direction. An average of 0.85 pound of explosives was used per cubic yard excavated. As walls were approached, the size of the drilling pattern was decreased, the explosive charges were reduced and more and more spacers were utilized.

The method of wall trimming followed was developed after considerable experimenting. By it, the 6¼- and 6¾-inch holes along the walls were placed at 5-foot intervals, and a 5x6-foot drilling pattern was used for those a short distance from the wall. Then three wagon-drill holes were put down in each 5-foot space between the main holes along the trim line, as indicated in an accompanying sketch. Of the wagon-drill holes only the center one was loaded and to about 4 feet from the collar. In addition, the main holes were "cushion-blasted." By this procedure the charge is taped to a length of detonating fuse. In this case the string of 1⅛x8-inch cartridges was lowered into the hole on the side farthest from the wall and the remaining space was filled with screenings.

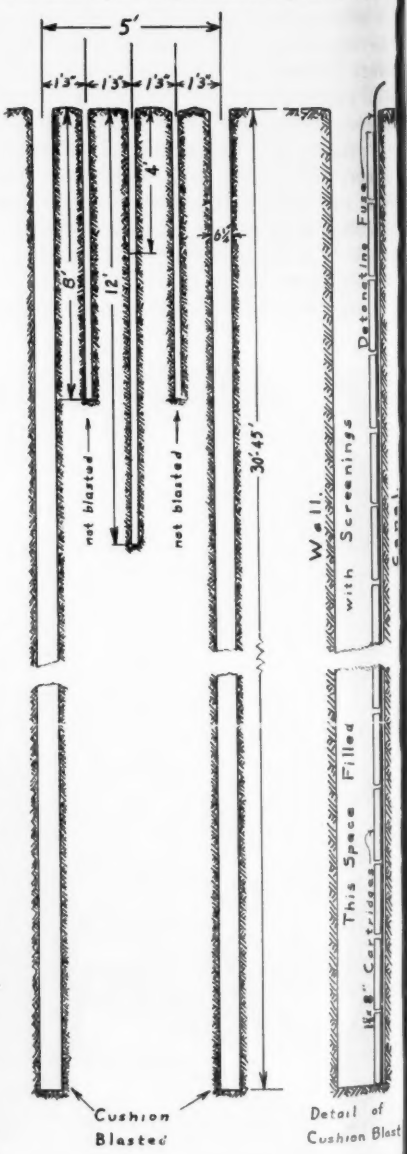
Digging of the canal is now virtually completed and was carried out from several points simultaneously. Seven shovels—one 6-, one 4- and two 2½-yard electrics and three 3½-yard diesels—were in service at the height of the operations, together with a fleet of 90 diesel dump trucks ranging in capacity from 11 to 20 yards. From 20,000 to 25,000 cubic yards of material was excavated per day.

The Ontario Hydro project staff is headed by Gordon Mitchell, project manager, with L. J. Gallagher, general superintendent; W. L. Fraser, project engineer; W. M. Hogg, assistant project engineer; E. J. Coleman, canal superintendent; W. Duncan, geologist; and M. F. Johnson, engineer at Shaft 3.

The Rayner-Atlas Company tunnel contract is under the direction of H. M. Scott, managing director, assisted by C. Larson, general superintendent; T. A. Lazier, chief engineer; W. F. Chisholm, control engineer; A. Judson, superintendent Shaft 1; and H. MacIsaac, superintendent Shaft 2.

J. R. Glaeser is chief engineer and project manager for Perini-Walsh & Associates. In charge of its tunnel work are A. L. Simpson, general superintendent; P. M. Putnam, project engineer; G. D. Phillips, field engineer; A. J. Ray, controller; and J. Doherty, M. A. Brown, and L. Owens, superintendents of shafts 3, 4 and 5, respectively.

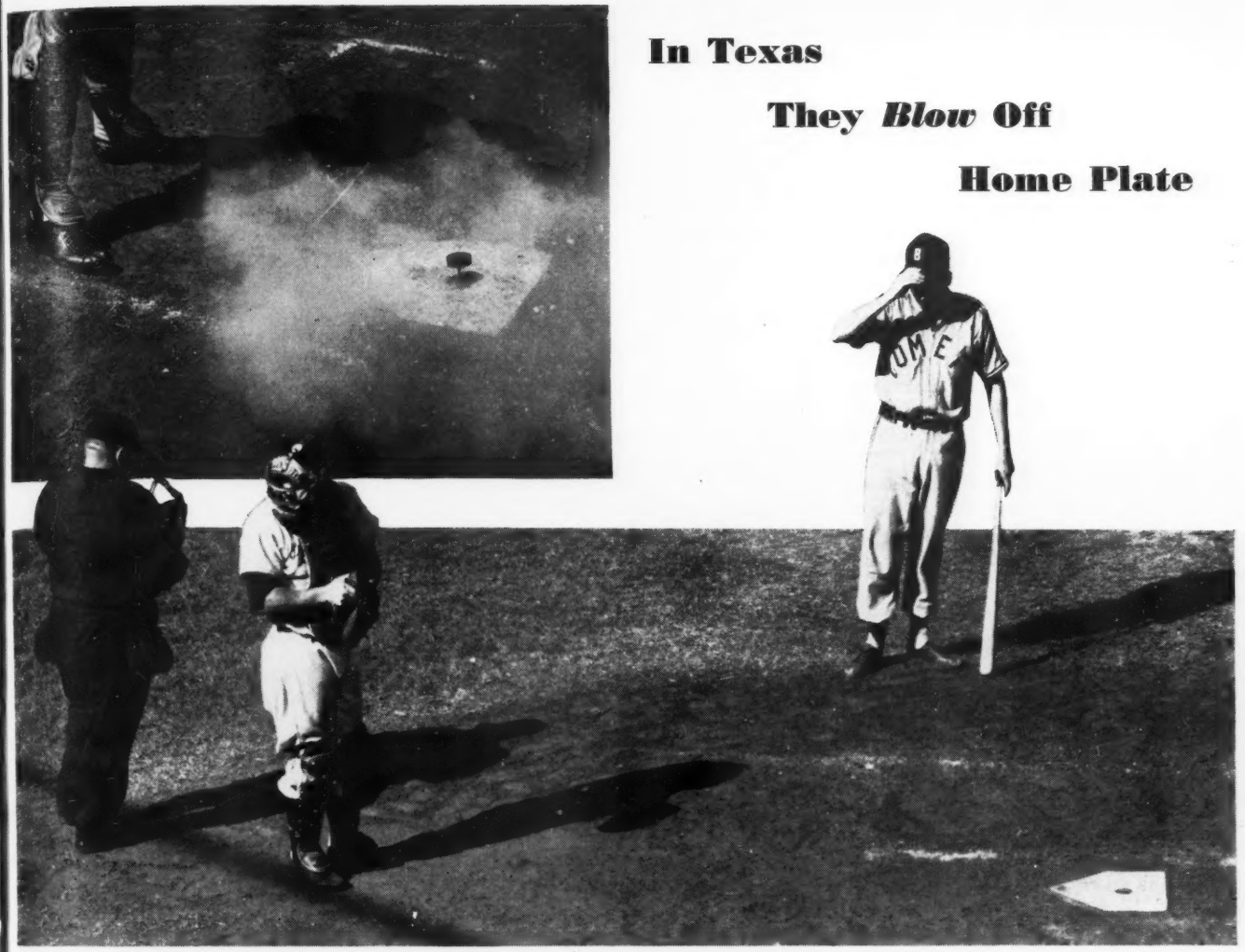
The author extends sincere thanks to all the members of the different staffs for the time and assistance given him in the preparation of this article and also to Ontario Hydro for permission to publish it.



LINE DRILLING CANAL WALLS

The picture shows Quarrymaster drills at each side of the canal putting down line holes to obtain a solid vertical face. Because the drill tower is at the front of the unit, holes could be put down within 15 to 18 inches of the wall. These holes, which were drilled after the first lift had been removed, were put down on 5-foot centers to depths of 30-45 feet, depending on their locations. Between each adjacent pair of holes, wagon drills put down three smaller and shorter ones, as indicated in the diagram. Only the center one of these was shot, the others serving merely to insure even rock breakage. To prevent shattering the rock along the side wall, the large holes were "cushion-blasted"; that is, a string of 1⅛x8-inch cartridges, taped to the detonating fuse, was lowered into the hole on the side away from the wall and the remaining space filled with rock screenings.

In Texas They *Blow* Off Home Plate



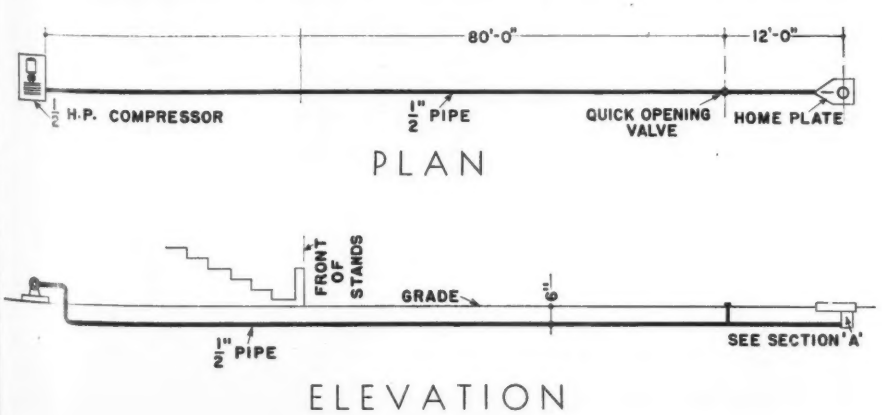
OPERATION "DUST-OFF"

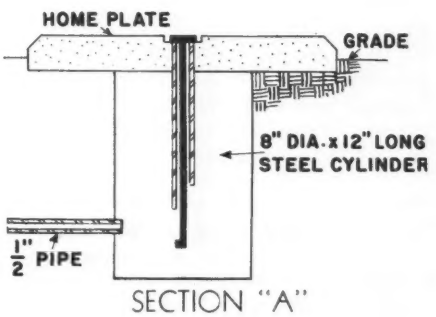
The umpire, left, is about to step on the control of the quick-acting valve 12 feet back of home plate. An instant later a disk rose in home plate (top). It was struck from below by an air blast which blew the dust in all directions.

EVEN the national pastime is getting an "assist" from compressed air. It's happening in Texas, where a lot of new ideas get their start. In one baseball park down there, home plate is dusted off by an air-puffing gadget that is controlled by a push button. If this innovation spreads, it will put an end to a homely touch that has come to be part and parcel of the game.

Ever since organized baseball has been played, the home-plate umpire has carried a pocket-size whisk broom with which to flick dirt from the surface of the pentagonal-shaped rubber slab that marks the basal projection of the all-important 17-inch-wide strike zone. From sand lots to the big leagues, the little broom has become as much of a trademark of the man in blue as his mask and strident voice. Nobody knows how many brooms have been worn out in this manner, nor how much horsepower has gone into the hoots and hollers and allusions to blindness with which frenzied fans have on countless millions of occasions assailed the arbiter as he stooped to perform this traditional bit of diamond housekeeping.

Considering all this, maybe the new way of doing the job won't be popular with the paying patrons, but at least it's progressive. Fans at the Sinton, Tex., park of the Plymouth Oil Company have adjusted themselves to the change





WORKING DIAGRAMS

The piping system is underground and unseen. Details of the construction at home plate are shown in Section "A."

with no perceptible reaction, and if Texans can keep their blood pressure down, maybe it can be done in Brooklyn and other big-time baseball hot spots. Jesse Thompson, business manager of the Plymouth "Oilers," is responsible for the blowing mechanism, but he didn't think it up. He saw something of the sort in a park in Wichita, Kans., and decided to adopt it for the oil firm's diamond, with improvements added by its engineers.

Baseball is serious business with Plymouth, just as it is with many other American industrial concerns. In 1951 the Oilers won the national championship among semiprofessional teams, and everybody in Sinton has been a little loony about the team since then. The company went overboard to the extent of building a new park, and the best was none too good when it came to equipping it. So when Mr. Thompson suggested emancipating the umpire from this thankless traditional chore, he was given a free hand.

Accompanying diagrams and pictures give details of the installation. The air is supplied by a ½-hp, motor-driven, 2-stage compressor housed back of the grandstand at ground level. It is delivered at 100 psi pressure to home plate by 92 feet of ½-inch copper tubing buried 6 inches deep. The line discharges into a steel cylinder which is 8 inches in diameter and 12 inches high and attached to the underside of the rubber slab. From the center of the plate, extending downward a few inches into the cylinder is a pipe containing a pin to the top of which is attached a steel disk that normally rests in a depression in the plate and flush with the surface. The lower end is bent at a right angle, and the projecting horizontal piece serves to stop the upward travel of the pin when it hits the bottom of the pipe.

Twelve feet back of home plate is a quick-opening valve with its control projecting just above ground level. Whenever the umpire decides to spruce up the plate, he simply steps on the valve. This admits compressed air to the cylinder beneath the plate, and the disk, which is elevated by the built-up pressure, stops about 1½ inches above the rubber. Air then rushes up the annular space between the pipe and pin, strikes the underside of the disk and is deflected in all directions. One big w-h-i-s-s-s-h, and the rubber is as clean as a hound's tooth; and the batter steps into his box and dares the pitcher to groove his fast one.

So far as the Plymouth people know, their system and the one in Wichita are the only ones in service. But some day the big leagues may get around to taking up the idea.

Pneumatic Tubes Shift Radioactive Capsules in

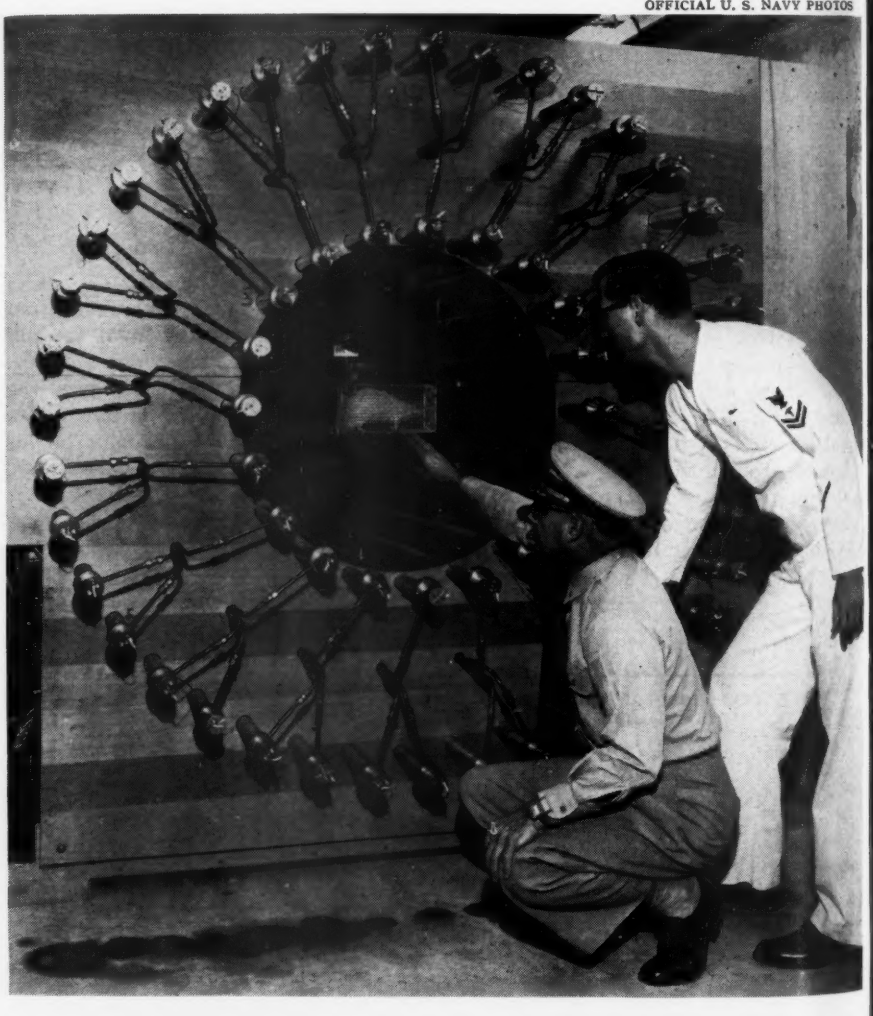
PSEUDO ATOMIC-RAY BOMBARDER

SIXTY pneumatic tubes perform a vital function in a machine with which Navy scientists are simulating the probable effects of an atomic-bomb explosion. With it they are irradiating various "targets," including animals, in an effort to gain information that will be helpful in devising ways and means of protecting human beings against the dangerous penetrating rays. It is hoped, for instance, that some immunizing drug may be developed.

The test apparatus, technically known as gamma-ray generator, is located at the Naval Medical Research Institute's medical center in Bethesda, Md., and is operated by the Navy's Bureau of Medicine and Surgery. It has solved the problem of how to direct the rays on a target from virtually all directions, thus enabling the scientists to duplicate in large measure what would most likely happen if a bomb were to go off nearby. Previously it was impossible to position existing sources of gamma rays so that they would do this.

The 60 pneumatic tubes, each 1½ inches in diameter and 17 feet long, are arranged in a generally cylindrical pattern. At one end they are close together and their ends form three concentric circles with a central opening 10 inches in diameter. Towards the opposite end they flare out and are then redisposed so that they describe two rings instead of three, with considerable space between the rings as well as between the tubes in each of them. The latter rings have an inside diameter of 3 feet and an outside diameter of 6 feet. These variations in the size of the open-

OFFICIAL U. S. NAVY PHOTOS



ANIMAL IN IRRADIATOR

A caged white rat is shown being pushed inside the gamma-ray generator by Capt. R. H. Draeger, while N. J. Marbois looks on. By thus subjecting animals to the perils of the rays, scientists hope to learn how to combat them. This is the large end of the circular pattern of pneumatic tubes in Room No. 2.

CHARGING THE TUBES WITH COBALT-60

An attendant is shown removing the end stop from one of the pneumatic tubes to permit the remotely controlled robot mechanism at his right to take over the job of inserting the radioactive capsules. Note the mirror above that makes it easier for an observer at a periscope in the control room to see what is going on.

ings are provided so that targets of different dimensions can be accommodated.

The source of the gamma rays is a cobalt isotope known as cobalt-60 and is obtained from the Oak Ridge, Tenn., Laboratories of the Atomic Energy Commission. About 200 grams is placed in each of 100 three-inch-long capsules, which are inserted in individual carriers and loaded into the tubes. The charge in each capsule amounts to twelve curies of radiocobalt, a curie being equivalent to the radiation emitted by one gram of radium. By varying the number of capsules, the volume of the radiation can be correspondingly regulated. Inasmuch as cobalt-60 has a half-life of 5.3 years, the apparatus can be used for several years before the supply will have to be renewed.

The generator is housed in a specially constructed, shielded building 47x30 feet in area. It is 12 feet high and has exterior walls of structural concrete 12 inches thick. The interior is divided into three compartments by a T-shaped barrier. The top of the T is a 4-foot wall of barite (heavy) concrete that runs almost the length of the building. Between it and the paralleling wall is a narrow space that forms the control room.

At each end of the barrier are 1-inch-thick steel double doors that open into exposure rooms, Nos 1 and 2, on each side of the stem of the T, which is a 5-foot partition of concrete in which scrap iron, lead shot and barite compose some of the aggregate. The tubes extend through the latter barrier, projecting 3 feet into Room No. 1 and 8 feet into No. 2. The parts of the tubes on both sides of the barrier are made of aluminum alloy; those passing through the barrier are of stainless steel for additional strength and to resist corrosion.

The cobalt carriers are loaded into the tubes by mechanical means remote controlled by the operator in the control room who can view the procedure through a periscope. The radioactive isotope is stored in the 3¼-ton container in which it was shipped from Oak Ridge. The vessel, nicknamed the "monster," has a cap or lid that weighs 530 pounds. The automatic loading equipment, which is mounted on an overhead monorail and performs many of its maneuvers with the aid of magnets, lifts the cover from the receptacle, picks out a cobalt capsule and places it in a carrier. Next it screws an end cover on the carrier and inserts it in one of the pneumatic tubes. After four tubes have been loaded, the "monster" is capped and attendants enter to put end stops in the tubes and to connect electric wires leading to a panel in the control room. Then four more tubes are loaded, and the procedure is repeated until the work is completed.

The carriers are placed in the tubes in Exposure Room No. 1 and drawn into them to a predetermined point by suction. By means of adjusting valves, a compressor installed in the control chamber is made to serve also as a vacuum pump and can exert a pressure of 7 psi or a corresponding pull. The machine is connected through a manifold and piping with the end of each tube in Room No. 2. Later, when the travel of the carriers has to be reversed, positive pressure is applied to push them back into Room No. 1.

To the inner face of each of the end stops of the tubes is attached a small piece of pipe the length of which can be adjusted so that it comes to rest wherever the carrier, approaching it from the other end, is to be positioned. By varying the lengths of the stops in the different tubes it is possible to dispose the capsules in such a way that they will well-nigh completely surround the target and yet none will block the rays directed from any of the others on the target. With the aid of the electrical connections previously mentioned, the locations of all the carriers in the tubes are always indicated in the control room by a series of lights on a panel, on which automatic timing and recording instruments and the master control switch are also mounted. The target inside the nest of tubes is observed from the control room by another periscope, one of these viewers being at each end of it.

In the interest of safety, there are no windows in the building and only one outside door. The electrical control hookup is such that a warning bell sounds 30 seconds before the radioactive material in the tubes is to be transferred from one exposure room to the other. Should a person happen to be in the room into which the carriers are to be moved, this gives him ample time to leave, or he can prevent the shift by operating a safety switch.

Preliminary work on the irradiator was started in 1949 by the Atomic Medical Division of the Naval Medical Research Institute, and the facilities were not ready for service until nearly three years later.

Editorial

RETURN OF THE SOCKEYE

ON THE Pacific Coast the salmon commands about as much respect as the cod does in New England. The fish is one of the western sea's leading money crops, and of the several commercial species the sockeye is the aristocrat. Its rich, red meat brings the best price of any. The sockeye is therefore eagerly sought after, and fishing-trade journals spell its name with a capital "S."

It is easy to understand, then, why the Pacific Coast fishing fraternity became excited this summer when hordes of sockeyes came back to the Fraser River in British Columbia after a 40-year period of comparative scarcity. Of incidental interest is the fact that their return was definitely related to the success of an engineering scheme carried out eight years ago. Their presence in large numbers gives assurance that a two-million-dollar construction gamble taken at that time is going to pay off bountifully in the years ahead.

This marks the first year since 1913 that the prized silvery food fish has been caught in abundance in Fraser River waters. From now on biologists believe it will be as plentiful as it ever was and perhaps even more so. If they are correct, there will be more cans of this tasty marine morsel on the shelves of food stores, more revenue for canners and employment for hundreds more people.

The first chapter in this story of the reappearance of the vanishing salmon was published in our May, 1945, issue. It told of the work that was being done to "unblock" the Fraser at Hell's Gate, 130 miles above its mouth, so that the sockeye might return to the spawning grounds from whence they came, as is their nature. The obstacles that kept them from doing this were partly natural, partly man-made.

The Fraser is British Columbia's largest river and reaches back 740 miles into the hinterland to drain an area as big as two Pennsylvanias. Where the stream cuts through the Coast Range to reach the sea it is swift and turbulent. Even before man added to the difficulties there it was a raging torrent, so much so in fact that its discoverer, Simon Fraser, called it "a place where no human should venture."

Intrepid empire builders disregarded his admonition, however, and built two railroads through the narrow gorge at safe heights above the stream. In carving a shelf for the Canadian National line in 1911-12, they precipitated rock slides that further choked the constricted waterway. As a result, the Fraser there rushed between walls 110 feet apart at a velocity of up to 20 miles per hour. In flood times it was around 90 feet deep; during periods of drought it dropped to a small fraction of that figure. Whenever the water was lower than 25 feet or higher than 45 feet few if any salmon bound for their upstream ancestral spawning beds could get through.

Young sockeyes make their way downstream to the ocean and remain there until they are four years old; hence the number that will return four years from now can be fairly well foretold by noting how many reach the spawning grounds this year. Until the advent of the rock slides, the Fraser produced enough sockeye salmon to keep twenty canneries operating. The catch in 1913 would have been worth around $50 million at today's inflated prices, yet four years later the pack had dwindled to one-fourth as much. Fishermen were pretty sure that the Hell's Gate bottleneck was to blame, but others tried to convince them that overfishing was responsible.

The Fraser is entirely in Canada but empties into the Gulf of Georgia not far from the United States border, and many of our fishermen take salmon there; in fact, in the preslide era they obtained more than half the annual catch at that point. In 1919 the Canadian Government proposed that an international commission be formed to study the sockeye problem and recommend remedial steps, the cost to be divided equally. Our Congress declined to ratify the measure because it also provided that the future yield should be divided equally between the two nations. Consequently nothing was done for years, and from 1920 to 1945 the annual catch was about one-twelfth the 1913 figure.

Finally, in 1937, our Government decided to go along with Canada, and the International Pacific Salmon Fisheries Commission resulted. It immediately set about studying salmon habits in an effort to determine how to proceed to increase the yield. For eight years it tagged young fish making their way seaward and noted how many of them were taken four years later. To insure the return of the tags it paid fishermen 25 cents for each one turned in. In one year 35,000 young salmon were tagged and less than 10,000 of them were caught. In 1941 the river below the obstructed stretch was clogged with fish for 6 to 7 miles and they couldn't move upstream for 36 days because of low water. When the stream rose, some got through but others were too weak to make it.

The studies convinced the commission that the slim sockeye pack would not improve until something was done to assist the returning spawners to negotiate Hell's Gate. They enlisted the aid of engineers in designing a model of a fishway that might accomplish the desired result. The model served as a guide for constructors who built similarly contrived structures on both sides of the chasm. Each consists of a series of pools arranged like stair treads but rising so gently that the weakened salmon do not have to jump far. The pools are large enough for the fish to rest in periodically before proceeding. The installation of the fishways entailed the removal of 24,000 cubic yards of loose slide rock and the drilling and blasting of 18,000 cubic yards of solid rock at a cost of around $2 million.

It was known at the time that final returns on the success of the scheme could not be expected until at least two cycles of the 4-year life span of the salmon had been allowed to elapse. The work was completed in time for the spawning run of 1945 and fishermen eagerly awaited the coming of 1953.

What they observed earlier this year was even more favorable than they had dared to hope. Up to July 10 the catch of Fraser sockeyes was approximately 700,000 fish. It broke all records, even those for the years before Hell's Gate became virtually impassable. According to *Pacific Fisherman*, this early season run consisted entirely of fish native to the spawning areas of the Stuart River, a westerly tributary of the Fraser and 700 miles upstream from its mouth. Before the bottleneck was removed the Stuart system had been substantially barren of sockeye.

Before the rock slide, the run of sockeye in the Quesnel, another of the Fraser's tributaries, had been far more important than that in the Stuart. It was virtually eliminated by the clogging of the main stream and also by the ill-advised erection of a mining dam on the Quesnel itself. After noting this year's early season catch of Stuart-spawned fish, Loyd A. Royal, director of the Fraser River operations of the international commission, opined that "the once-great Quesnel Sockeye run is expected to appear in abundance in the Fraser River fishery later this year, for the first time since 1913."

Pacific Coast fishermen are naturally jubilant over these developments, and the only regret is that remedial steps were not taken earlier. Canned sockeye is selling for more than $1 per pound right now, and fishermen are getting 22 cents per pound from the canneries for whole fish, plus a bonus that may run three cents more. If Hell's Gate had been made passable for spawners in 1914, it is estimated that salmon sales since then would have been somewhere between $200 million and $1 billion greater than they were.

This and That

"So at lunch time, when I couldn't shut the air off, I put some bubble gum in the end of the hose."

Tubes Transport Steel

Traveling in pneumatic tubes faster than a man can run, open-hearth steel samples are carried about 1/10 mile from furnace to laboratory in less than twenty seconds at the Roebling, N. J., steel mill of John A. Roebling's Sons Corporation. The tube system simplifies the problem of maintaining consistently high-quality steel by making possible frequent control checks. Several samples can now be analyzed in the time formerly required to handle one. The installation is not unique in the steel industry, but it has some distinctive features.

The 3-inch pneumatic tubes, installed by Lamson Corporation, of Syracuse, N. Y., service all nine open-hearth furnaces. Steel samples may be sent directly from any one of these to the lab, analyzed in two or three minutes, and then returned seconds later to one of the three pickup points. This enables smelters to handle more furnaces than before and with less physical effort.

★ ★ ★

New Gravel Process

The Dravo Corporation, of Pittsburgh, Pa., is refining river gravel and producing high-grade concrete aggregate by means of the heavy-media separation (sink-and-float) process that was developed for recovering ore from gangue. Dredged gravel is placed in a heavy liquid made up of finely ground magnetite iron ore and water. Everything in it that is of lower specific gravity than the prepared fluid floats and can be skimmed off. This permits eliminating wood, coal, porous rock fragments and other unwanted substances. The heavier particles sink and are transferred to barges for delivery to construction jobs. The pioneer plant handles an average of 150 to 175 tons of feed gravel per hour and has treated as much as 225 tons. The process, which was worked out in conjunction with the American Cyanamid Company, promises to make it possible to use gravel that has previously been ruled out because of contamination.

★ ★ ★

Novel Booster System

The German publication *Glueckauf* tells of an underground booster compressor in a Ruhr coal mine that is operated by power from the regular air-distribution system. The latter is under only about 60 psi pressure at that remote point, and some of the air is used to boost the remainder to 90 psi. Tests conducted with two hand-held rock drills indicated that it was more economical to run them at the higher pressure. While air consumption rose with faster operation at the higher pressure, drilling speeds increased at an even greater rate. Drill maintenance costs likewise went up, but the over-all result was a 21 percent monetary saving. It was also determined that the pneumatic coal-loading machine was more efficient at the higher pressure. Details of the design of the booster were not given.

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Big Rig Controlled with Air

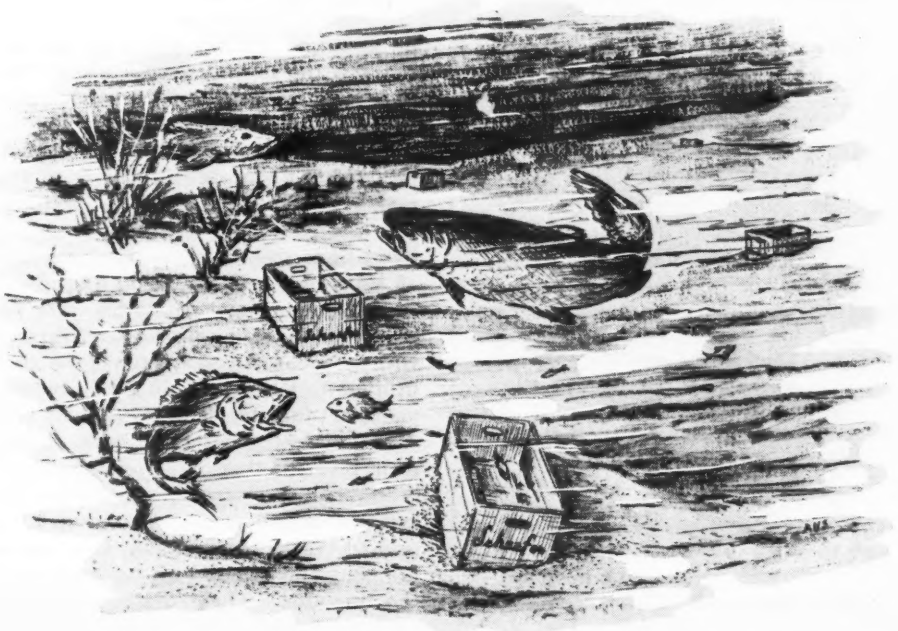
A rotary rig that can drill oil wells to a depth of 25,000 feet has been constructed by Wilson Manufacturing Company, of Wichita Falls, Tex., for the San Joaquin Drilling Company of Santa Maria, Calif. It is powered by three 750-hp diesel engines. All the principal operations will be controlled by the driller by means of air valves mounted on a console that may be moved to various vantage points. Air lines can be quickly connected to it and extended, if desired. Engine throttles, clutches and brakes are all air actuated. One pneumatic clutch makes it possible to run the engines at either of two speeds and will, it is claimed, save as much as 5 percent in power.

Beer Cases Make Homes for Fish

A LOT of concrete has been deposited under the surface of the sea, but probably none of it for the purpose we are about to mention. Off the western end of Fire Island, south of Babylon, Long Island, N. Y., 14,000 wooden beer cases partly filled with concrete have been sunk to the floor of the Atlantic Ocean to provide habitats for game fish.

It is generally known that bottom fishing is better where there is an abundance of marine growth for fish to feed on. For this reason favored angling spots are around sunken ships and other structures that give the organisms something to which they can attach themselves. At Fire Island, the shifting of the sandy bottom in recent years has covered up projecting anchorages, thus reducing feeding and spawning grounds and affecting fishing adversely.

Now, through the generosity of R. J. (Rudy) Schaefer, Brooklyn brewer and sportsman, man is assisting Nature to become more receptive to the finny species. The idea was born in the mind of



Paul Azzolini, a fisherman and the owner of a pattern shop opposite the Schaefer Brewery. Noticing hundreds of wooden cases that were being discarded because of a change to fiber containers, he suggested using them to attract fish. Somebody passed the idea along to Jack Brawley, late writer of a rod-and-gun column in the New York *Journal-American*, and he in turn approached Mr. Schaefer.

The brewer not only donated the cases but also offered to pay for the concrete. Associations of boatmen and fishermen in the area in question helped out, and the first bargeload of 1000 was towed out last year and dumped at the selected spot. This year the job was completed, as many as 5000 cases having been handled at a time. Seedling mussels likewise have been deposited to give the fish-food project a quick start.

By only partly filling the cases, space is left for fish to seek cover from natural enemies and to create an environment favorable to spawning. Marine biologists say that minute marine life will encrust the rough wood and concrete surfaces within a short time. Some beneficial effect on fisherman's luck is looked for this year, and by 1954 it is expected that fluke, sea bass, blackfish and porgies will be far more numerous than they now are. The sanctuary has been named the Rudy Schaefer Fishing Grounds.

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Maine Versus Russia

The State of Maine, just one-forty-eighth (politically) of the U.S.A., and not an outstanding industrial region at that, packs about half as many cans of food products in a year as does all of Russia, which has 200 times as many people and 260 times as much land as the Pine Tree State. This fact came to light when the Maine sardine industry celebrated its eightieth anniversary and presented to Gov. Burton M. Cross the one-hundred-millionth case packed there. As there are 100 cans in a case, 10 billion cans of the little fish have been sent to market. The Maine sardine pack last year reached 345 million cans, amounting to three-quarters of the state's canned-food output. The sardine fishing industry employs 1200 people and 350 boats.

"Hear that son? Now try it again."

★ ★ ★

Vibration Benefits Castings

Vibrating metal castings while they are solidifying in their molds has several beneficial effects, according to an article in *Foundry* by W. Rostoker and M. J. Berger, metallurgists of the Armour Research Foundation of the Illinois Institute of Technology, Chicago. They were reporting on work they had done under the sponsorship of the Frankfort Arsenal. Vibration, they state, tends to degas molten metal, to disperse immiscible liquids and solids, to suppress the columnar growth of crystals and, in the case of some metals, to refine the grain size.

"Now careful this time!"

Vibration is divided into sonic and ultrasonic types, depending on the frequency, the line of demarcation being at about 17,000 cycles per second. Some ultrasonic vibrations range as high as 200,000 cps and are obtained from a piezoelectric source. Vibrations of the magnitude of 200 cps can be produced with pneumatic vibrators, and there are indications that these tools are capable of bringing about some of the effects noted in commercial foundries. The researchers used a spring-loaded vibrator with a 1-inch-diameter piston of the kind utilized for jolting sand in molds on conventional foundry tables.

Experiments relating to grain refinement revealed that under pneumatic vibration at pressures up to 60 psi, the greatest change occurred around 12½ psi and that only slight additional benefits could be counted on by increasing the pressure. These findings indicate that satisfactory results can be obtained with equipment normally found in commercial foundries.

"I'd just as soon had several pan fish, dear."

The research work in question was conducted with various ferromagnetic alloys. Previous experimenters used antimony, cadmium, duralumin and alloys containing tin, bismuth, lead and zinc. Patents on methods of vibration have been granted from time to time since 1934, but little has so far been done on a commercial scale.

★ ★ ★

Laudable Service Records

Reports of outstanding service records of industrial products are not unusual but always intriguing. Two just came to our attention. A belt that has been carrying grain continually for 64 years has been retired by a Minnesota concern. The 24-inch carrier was turned out by New York Belting & Packing Company, of Passaic, N. J., in 1889. It was one of the first conveyor belts of cotton duck and rubber, previous ones having been made of leather or woven fabrics. Still not worn out, it was returned to its manufacturer for careful laboratory examination.

Of considerably more recent origin is a die, lined with tungsten carbide, that has drawn more than 5000 tons of steel bars without its opening being appreciably enlarged. Delivered by the Carboloy Department of General Electric Company to the Wyckoff Steel Company in March, 1951, it remained in service 26 months, when a crack developed. Meanwhile, its internal diameter had increased only from 2.4315 inches to 2.434 inches—a mere 0.0025 inch. In all, 10,420,955 pounds of stock was drawn through the die with $^1/_{16}$-inch reduction. This amounted to 110 miles of bars—which is equivalent to the capacity of 260 railroad cars.

Jap Pillbox Resists American Air Tools

TEDIOUS DESTRUCTION

Workmen at the top-right are engaged in piercing the heavily reinforced roof with paving breakers. The picture above shows the pillbox in the background during the early stages of the work. In the foreground are two portable compressors under a tamarind tree, a species that sometimes attains a diameter of 10 feet and a height of 100 feet. In the view at the right the fortification is seen partly demolished. Rising above it is a pile-driving type of rig that was used in breaking up the roof. On the far side of it are guides for a falling weight or ram.

ACCOMPANYING pictures show Indonesian workmen in the City of Djakarta demolishing a "pillbox" that was left by the Japanese army as a memento of its occupation from 1942 to 1945. The fortification was constructed so solidly that no effort had been made to raze it until the plot in which it stood was selected as the site for a hotel and stores building.

The removal job was made more difficult because Indonesian civilians are not allowed to use explosives, a precaution born of the troublous times through which the islands have been passing. Blasting is done solely by military forces, and they usually have a backlog of several months' work. Because time was important in this instance, the contractor, N. V. Associatie Selle & de Bruyn, elected literally to tear the structure to pieces and set to work with the aid of ten Ingersoll-Rand PB-6 paving breakers powered with air supplied by three I-R diesel engine-driven portable compressors: two 105-cfm units and one 160-cfm.

The pillbox was about 10 feet high and 40 feet square with some internal dividing walls and was constructed of concrete reinforced with iron bars and steel rails that represented nearly one-third of its weight. Exterior walls were up to 5 or 6 feet in thickness. Approximately four months was required to break up the structure and dispose of the debris.

Djakarta, formerly Batavia, is a city of 2,800,000 and the capital of the Republic of Indonesia. It is on the Island of Java, one of five large and about 3000 small islands that make up the country's area of 735,000 square miles, roughly three times the size of the State of Texas but populated by more than 75 million persons.

New Building Material

A BUILDING material that is said to be about one-fifth as heavy as concrete and five times as strong, based on a density of 100 pounds per cubic foot, has been developed in Sweden and is being manufactured in this country under an exclusive license by United States Plywood Corporation. Named Zeprex, its basic component is monocalcium silicate combined with chemicals and water. It is cellular in structure and is being made in the form of beams and slabs and normally in densities ranging from 25 to 50 pounds per cubic foot, depending upon its use. The material can be sawed, drilled, cut with an ax and has good nail-holding properties, it is claimed.

Oxygen Equipment for the Mount Everest Expedition

ONE of the factors that contributed largely to the success of the recent Mount Everest Expedition was the effectiveness of the oxygen breathing apparatus designed especially for the climb by a number of British concerns in cooperation with several government departments. Equipment used by earlier expeditions that have attempted to conquer the highest peak of the Himalayas were more or less unsatisfactory from the mountaineers' viewpoint largely because efficiency was sacrificed for lightness. Because of this, most climbers have put little faith in the apparatus and considered it more of a bother than worth-while. But because of the great altitudes that would have to be reached, the members of the latest expedition decided to wear oxygen breathing apparatus at elevations exceeding 21,000 feet for all purposes, including sleeping.

The equipment built consists basically of a high-pressure cylinder, a pressure-reducing regulator, a manifold, a low-pressure storage reservoir, an economizer and a face mask. It is easy to operate, the user merely donning the mask and opening one valve. This causes the oxygen from the high-pressure flask to pass through the reducing regulator and then to the manifold, which has two controlling orifices that supply the wearer with oxygen according to his needs.

At first, a flow rate of 2 or 4 liters per minute was believed to be the optimum for an altitude of 27,000 feet, but subsequently additional manifold assemblies were made to provide 2.5 or 5 liters and 3 or 6 liters so that the one that would best meet conditions could be chosen right on the spot. Generally, the orifice with the higher rate of flow is intended for use when the climber is active and that with the lower rate when he is resting or sleeping. The outlet of the dual manifold is connected by a short length of rubber tubing to the economizer which, in turn, is connected by a similar line to the mask. When the wearer inhales, a valve in the economizer opens, thus feeding to the lungs all the air stored during exhalation, when the valve is closed.

Oxygen breathing sets each with three high-pressure cylinders were manufactured for the expedition, though it was believed that two flasks, which would reduce the weight of the equipment from 40 to approximately 29 pounds, would suffice. The cylinders were constructed of anodized lightweight alloys and each was charged with about 800 liters of oxygen (28.2 cubic feet) at 3300 psi pressure. The entire apparatus is mounted haversack fashion in a tubular frame shaped to fit the back and fastened in place by adjustable straps of webbing. Two similar straps hold the flasks in the frame and can be released quickly to discard an empty. In all, twelve outfits were built, one for each member of the group, together with 100 standard cylinders: 40 for the packs and 60 valved flasks for use with loose regulators for sleeping sets.

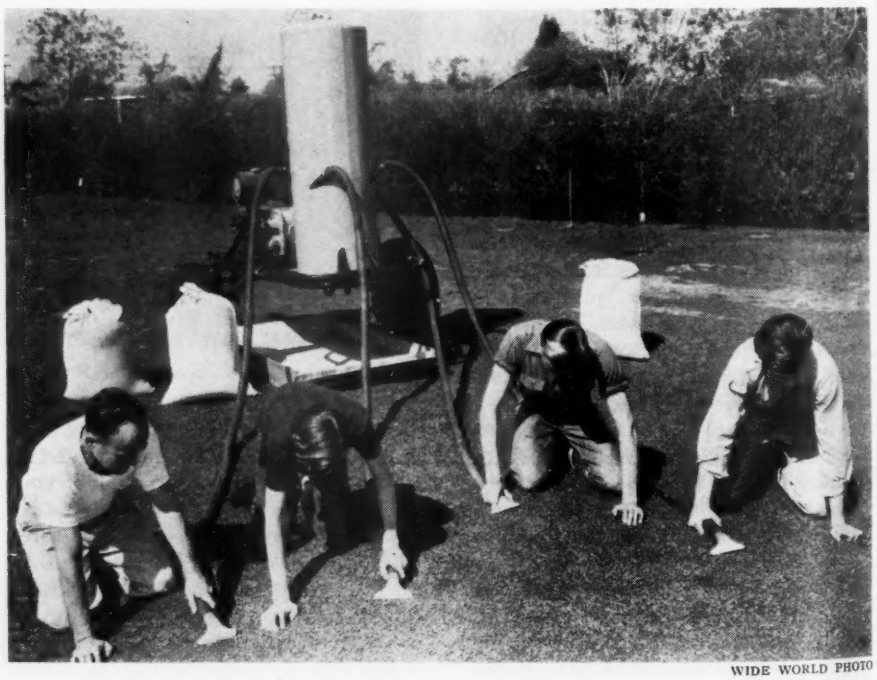
Because it was considered likely that the cylinders would be thrown away, especially upon reaching the summit of the mountain, each was decorated with a picture of the British flag. But when it was found that a number of them weighed 7½ instead of 8¼ pounds, it was decided to distinguish them from the others by marking them with two decals of the Union Jack. This enabled the climbers to save them for the final dash to the peak.

Mines Need Big Fans to Supply Ventilating Air

IN the last decade, as plant sizes have doubled and trebled, as mines have become deeper and the distances between working faces and ventilating shafts have grown in length, the demand for air has steadily increased, and today huge fans are in use the world over to meet that need. The International Nickel Company has recently installed a 20-ton 300,000-cfm fan in its Creighton Mine in Ontario, Canada. This unit has a 124-inch impeller with twelve adjustable blades and is driven by a 350-hp motor.

The 20-ton machine is shaped like a giant malted-milk mixer. It stands 42 feet high, has a diameter at the inlet of 15 feet and its 124-inch impeller has twelve stainless-steel blades the pitch of which can be adjusted to handle more air as mining operations proceed. Stationed at the top of a return shaft, the upward-drawn air induces a flow of fresh air down another shaft, through broken caved ore in stopes and through slusher drifts and other passageways.

Another big variable-pitch fan with a diameter of 209 inches has been mounted in a 20-foot-diameter upcast shaft in the Broken Hill Mine in Australia. It is the first of two interchangeable machines to be put in service there and delivers 720,000 cfm. The volume is eventually to be stepped up to 900,000 cfm by enlarging the "orifice" from 170 to 181 square feet. The power unit consists of an 850-bhp induction motor and an auxiliary 65-hp d-c motor which is coupled to the main shaft and connected to the slip rings of the induction motor through a mercury-arc rectifier. By this arrangement the output of the main motor, with the rotor running at reduced speed, is converted into useful power instead of being dissipated as heat. These and similar installations have prompted the query. "How big can fans get?"



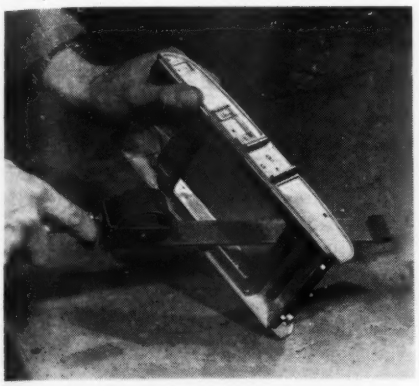
WIDE WORLD PHOTO

LAZY MAN'S LAWN

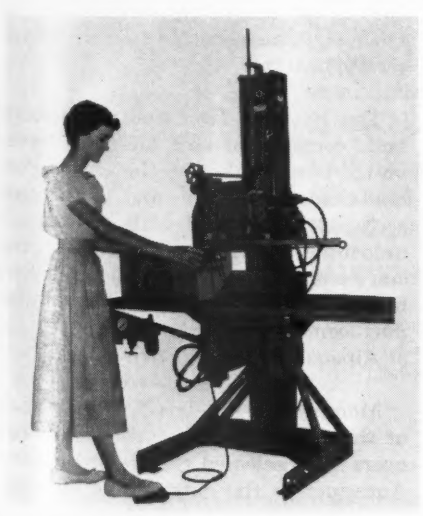
Because he disliked mowing, Blaine H. Knox replaced grass with dichondra on his half-acre lawn at Baldwin Park, Calif. Dichondra has close-lying kidney-shaped green leaves that require no cutting or maintenance. It reseeds itself every year and yields a surplus of seeds that sell for $8 a pound. Pictured is the vacuum-cleaner type of machine Knox devised to harvest his crop. Leaves, sticks and dirt drawn in are separated from the seed pods in the tank, and when the seed compartment is full it automatically dumps its contents. The seed must be hulled before planting. A pound is enough for a lawn of average size.

Industrial Notes

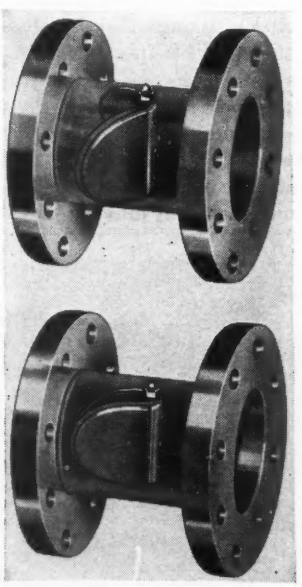
Something different in abrasive files that eliminates resharpening has been announced by Monarch Machine Shop, Inc., and Minnesota Mining & Manufacturing Company. The tool is used like a conventional metal file but, unlike the latter, offers a renewing cutting surface. Called Red Flash, it is suitable for deburring and other filing and finishing jobs in the metalworking field. It has an 11-inch stroke to increase cutting speed and features a 6-foot roll of abrasive cloth that is dispensed as needed. Rolls containing 50 yards of material, enough for 25 refills, are available in grit sizes ranging from 24 to 320. The Monarch file is made in 1- and 1½-inch widths.



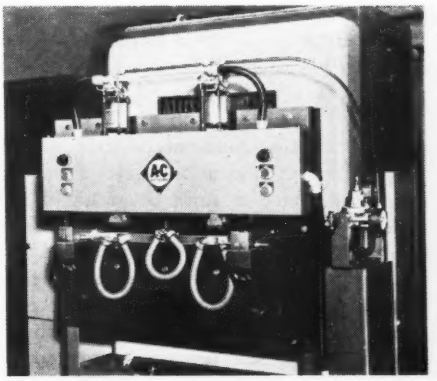
Tops and bottoms of center-slotted cartons as well as partial or full overlap containers can be closed in one operation, it is claimed, by an air-operated model added by International Staple & Machine Company to its line of retractable anvil staplers. The machine permits closure from the outside after cartons are filled with merchandise, as well as concealed stapling by which the fasteners are clinched after passing about two-thirds through the walls of the corrugated or fiber containers. A roller table, that can be raised or lowered in conformity with the height of conveyor systems, guides the work and positions it between the stapling heads, one above and the other below the table. The unit is foot controlled and uses air ranging in pressure from 50 to 80 psi, but is factory set for 60 psi. It automatically adjusts itself to take cartons varying 5½ inches in height but can be set in two seconds to accommodate higher ones. Called Staple King, it is said to handle containers from 2 to 28 inches wide and 2½ to 40 inches high at the rate of 350 and more an hour. In addition to a standard air filter-lubricator-regulator, warning lights flash when the supply of staples is low.



Technocheck is the name given a new check valve that is designed for any gas- or air-line service requiring quick opening and closing. Of simple construction, the body is of steel and the inner part consists of two leaves elliptical in section and made of rubber or other pliable material bonded to a center post and to reinforcing plates. Because of this flexibility, the valve is said to open quickly under discharge pressure from a compressor or blower and to assume a streamlined position that offers minimum resistance to flow. When pressure is reversed, it snaps shut tight, sealing the bore of the chamber. The valve is suitable for use as a nonreturn, antisurge or check valve, and is available with flanged or screwed ends in sizes ranging from 4 to 16 inches and in standard units for 50 psi pressure and 200°F for air and noncorrosive gases. Special types are built to order by the Techno Company.



Through the development of a 2-station fixture designed for interlocked alternate operation, Allis-Chalmers Manufacturing Company has measurably increased the output of its 10- and 20-kw alternating-current induction heaters. The unit is air powered and electrically controlled and has two separate sets of bus bars to which identical or different work coils can be connected. This enables the operator to unload and reload one while the other is supplying thermal energy to the part being heated. The necessary pressure to insure positive bus-bar contact is provided by two pneumatic cylinders actuated with air at 60 psi pressure. The control circuit is arranged to make and break contacts only when the coils are not receiving power and to prevent the high-frequency current being switched from one coil to the other during the heating cycle. The fixture can be bolted to the front of all but the earlier models without changes.

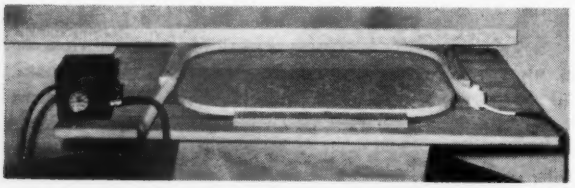


Seepage from irrigation systems, reservoirs, stock ponds, etc., is checked, says Johns-Manville, by its Pre-Fab Liner. The asbestos material is supplied in 3-foot-wide rolls containing 108 square feet and having 3-inch laps which are joined with fast-setting cement. When laid, the lining is covered with backfill for protection.

Many advantages are claimed by Gustin-Bacon Manufacturing Company for its new pipe insulation molded in one piece of fine blown-glass fibers bonded with a phenolic resin. Light in weight, easy to cut and nonbreakable, it is applied by spreading it apart, as the accompanying picture shows, and snaps back into shape to fit snugly. Designated

as Ultrafine Pipe Insulation, it is also said to possess high thermal efficiency, to resist the attack of most acids and alkalies, and to be proof against rot and mold. It is available in four thicknesses —½ to 1½ inches—for a wide range of pipe sizes.

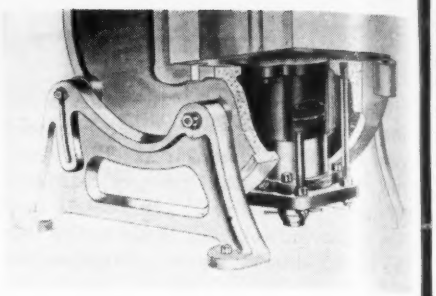
For furniture makers and others that apply plastic edging to table tops and the like, there is now available a so-called Thermo-Flex Self Edger that does its work at the flick of a switch and the turn of an air valve. The unusual feature of the equipment is a high temperature Fiberglas bag that furnishes both the heat and the pressure required to



effect a bond. With glue applied to the edge of the article being manufactured and to the edging, the latter is bent into position and, with the bag fitted around it, the assembly is placed on a caul board, as shown in the accompanying illustration. That done, the electric connection of the thermo converter is plugged into a standard 110-volt circuit and compressed air from a shop line is admitted into the bag. Temperature is thermostatically controlled during the curing period, and firm even pressure is maintained by use of an air regulator. Bags up to 144 inches long and 24 inches wide are available, the standard size being 72x2 inches. The electro-bond press is produced by Woodwelding, Inc., specialists in wood-gluing equipment.

Super-Grip is the trade name of a chuck for heavy machine-tool operations that is said to develop an exceptionally high thrust. A simple booster assembly within a self-contained pneumatic cylinder multiplies the air pressure on a ratio of 8 to 1, causing a steel diaphragm to open and close integral steel jaws. According to the manufacturer, Sheffer Collet Company, the use of a strong diaphragm makes for a high torque factor, and the stepped-up power insures repeated full jaw opening regardless of fluctuating line pressure. Built-in stops prevent overdistortion of the diaphragm. The chuck is supplied in shapes and sizes specified by the user.

A new model pneumatic die cushion designed primarily for inclinable presses has been announced by Dayton Rogers Manufacturing Company. The unit is self-contained and may be used with or



without a surge tank. It features a means of internal guiding to compensate for off-center loading of the hardened and ground pin pressure pad or wear plate and is provided with a combination air-regulating valve and gauge to insure constant work pressure on the pad. The Model DB Full Universal Pneumatic Die Cushion, as it is designated, is available in eight sizes from 5 to 18 inches and exerts ring holding pressures ranging from 1 ton through 14 tons with air at a line pressure of 100 psi. It is suitable for all deep drawing operations and can be used in connection with many forming dies and equipped for bolster-plate mounting.

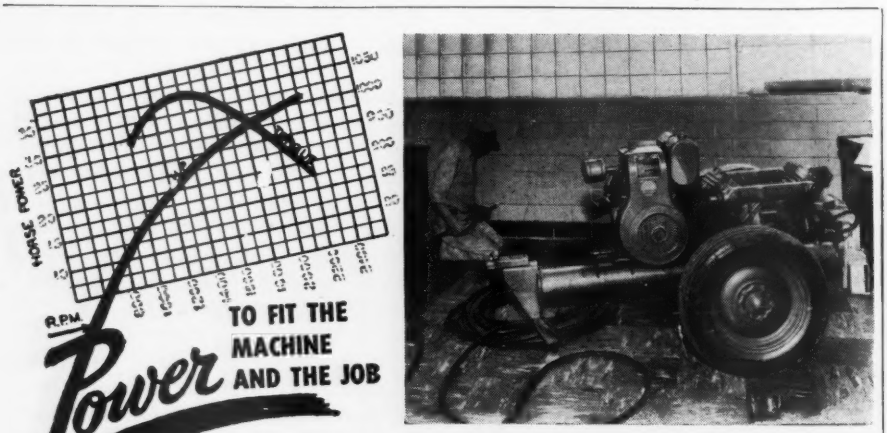
Neoprene is being made into overshoes by Tingley Rubber Corporation for men who must work around oil, solvents and acids. Unlined, the rubbers can be reversed for cleaning and come in three sizes for No. 6 to 12 shoes.

Five U. S. Navy minesweepers are being equipped experimentally with reinforced tanks of Fiberglas-plastic ranging in capacity from 100 to 1687 gallons for storing fresh water and oil. Besides being resistant to corrosion they are from 30 to 40 percent lighter than the monel and aluminum tanks they are replacing.

Rust-Cutter is the name of a new product put up by James R. Kearney Corporation especially for the use of electric linemen. Pressure-packed in a 6-ounce can that dispenses the oil in a fine spray, it is said to loosen corroded nuts, bolts and studs on crossarm braces, switchgear boxes and similar hard-to-reach equipment within two minutes after application.

The *Paul H. Townsend* is the fourth bulk cement carrier placed in service on the Great Lakes by the Huron Portland Cement Company and, like its predecessors, is equipped with a pneumatic unloading system. Its 3580-ton cargo can be discharged in approximately ten hours. The ship is to be used to transport cement from the company's mill at Alpena, Mich., to distributing depots.

Members of the Los Angeles section of the American Society of Civil Engineers have selected the Colorado River Aqueduct as the outstanding engineer-



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Ingersoll-Rand Compressor

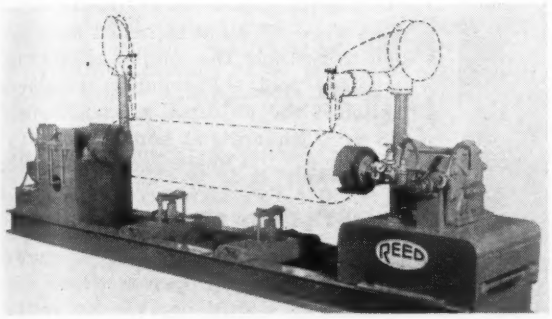
Wheeling a modern, mobile compressor to any spot it's needed is easy when it's an Ingersoll-Rand. Then doing a day's work on *location* is also a "sure thing" if a Wisconsin Heavy-Duty Air-Cooled Engine supplies the power.

The search for full-rated power that's dependable ends almost always with Wisconsin Engines . . . *first choice* everywhere, 3 to 30 hp. For example, every Wisconsin Engine crankshaft rides at both ends on tapered roller bearings, reducing the chance of bearing failure. Also, Wisconsin Engine magnetos mount on the OUTSIDE for easy servicing, but most important each magneto is equipped with an impulse coupling for quick starts in any weather. Steady running is assured, too, because of fool-proof air-cooling, summer and winter. Follow the lead of many who say, "Wisconsin Engine Power fits the machine and job." And, write today for "Power Magic" covering all 4-cycle single-cylinder, 2-cylinder and V-type 4-cylinder models, 3 to 30 hp.

WISCONSIN MOTOR CORPORATION
World's Largest Builders of Heavy-Duty Air-Cooled Engines
MILWAUKEE 46 WISCONSIN

ing work of Southern California. The aqueduct extends 457 miles from the Colorado River and now supplies 48 cities with water. These communities make up the Metropolitan Water District, which includes more than three-quarters of the population and assessed valuation in Southern California.

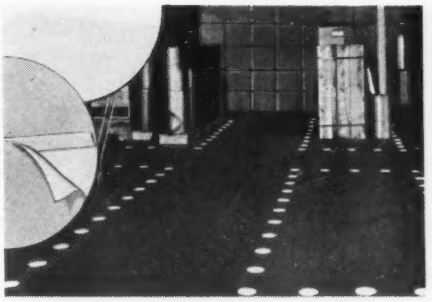
Three double-acting air cylinders are put to good use in a fixture designed by The Reed Engineering Company for positioning and holding domestic hot-water tanks for girth-seam welding. Mounted on the bedplate of the unit



are two jacks, each powered by a 3x6-inch cylinder, that lift the shell of the tank a predetermined height, depending upon its diameter. Next the heads are forced onto the ends of the shell by a horizontal 12x12-inch cylinder that exerts a pressure of 5 tons with air at 100 psi. Both heads are then welded on automatically while the work is rotated at from 0.16 to 1.6 rpm. The combination assembly press and welding fixture is designated as Model AW-205 and is made for tanks ranging from 9 to 24 inches in diameter and 12 to 84 inches in length. It is equipped with 4-way air valves and a filter-regulator-lubricator.

Motorists will soon be able to get a battery, it is reported, that can be adjusted for summer and winter driving. It is to be put on the market under the trade name of Weathermaster by Willard Storage Battery Company, which developed it. The changeover is made by a manually operated key through which a battery's water-storage capacity can be reduced for cold-weather service and increased for summer use to lower the gravity of the acid and thus provide more resistance to the damaging effects of overcharging.

Aisle markers recently announced by W. H. Brady Company for industrial and many other uses are made of a durable plastic backed with a heavy-duty



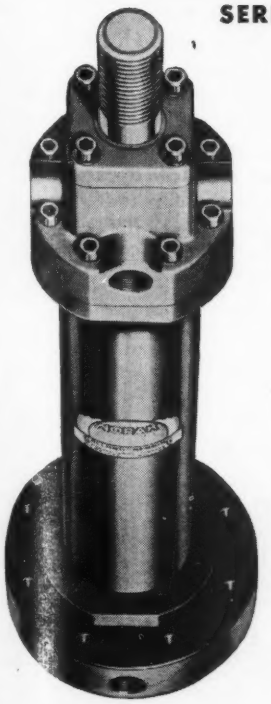
pressure-sensitive adhesive protected until application by a 2-piece paper liner. They are stocked in four bright colors—yellow, red, green and white—and in 2-, 3-, 4-, and 5-inch diameters 0.005 inch thick. Directional arrows also are available, and disks of special sizes, colors and shapes are made to order. Acids, oil, grease, salts, water and most common solvents do not affect the markers, says the manufacturer.

For blind-hole tapping, Destiny Products Company is offering a lubricant in stick form under the name of Hypertap. After the hole has been drilled and the chips have been blown out, a piece of the lubricant is dropped in. Then, when the tap cuts the threads the lubricant is extruded, picking up the thread chips and carrying them along with it. The sticks are up to 1 inch in diameter and up to 7½ inches long.

Proved in Service...

NOPAK

SERIES 1500



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The successful design, construction and application of high-pressure hydraulic cylinders, under a wide variety of working conditions, is the result of specialized knowledge based on years of experience in the field of high pressure hydraulics, carefully selected materials, special skills and fine workmanship. Reports from users indicate that NOPAK Series 1500 Hydraulic Cylinders have established new standards of design, precision, construction and performance in the high pressure field. They have been "Proved in Service".

NOPAK Series 1500 High Pressure Hydraulic Cylinders are available in 5 Standard Mountings, in diameters from 1½" to 8", in Adjustable Cushion or Non-Cushion Types.

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Refer to Sweet's File for Product Designers or write for Bulletins HC-1 and SW-1.

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Representatives in Principal Cities

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VALVES AND CYLINDERS
DESIGNED for AIR and HYDRAULIC SERVICE

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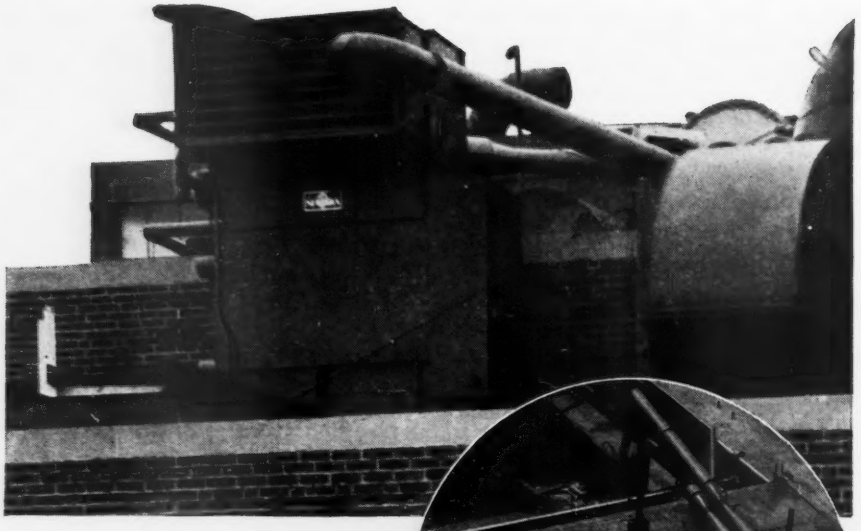

DRY, FRESH AIR For a Supersonic WIND TUNNEL

● New and improved, this NIAGARA METHOD that effectively dries outdoor air for a wind tunnel used for testing at supersonic speed, can be trusted to give you the best air conditions for your purpose:

- **to dry your materials or products**
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- **to protect your moisture-sensitive processes**
- **to give you an atmosphere in which your product can be packaged or stored safely.**
- **to give you exactly the right atmospheric conditions for testing materials**
- **to put "fresh air" back into your air conditioning, increasing its capacity and effectiveness**

The Niagara "fresh air" Method removes the excess moisture from outdoor air by contact with an absorbent liquid in a spray chamber. The liquid contact temperature and the absorbent concentration, both controlled thermostatically, determine the amount of moisture in the conditioned air. Heating or cooling the air is a separate function. Therefore, you can easily and inexpensively have a precisely controlled condition without the use of moisture sensitive instruments.

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QUOTES

—FROM HERE AND THERE

Balloon Floats a Ship

"A minesweeper, stuck with a hole in its hull among the rocks at St. Ives, Cornwall, was released with the aid of a barrage balloon which was plugged into the hole and then inflated."

Easton (Pa.) Express, June 23, 1953

Air Tools Discourage Theft

"One foreman in the Midwest reported that since his plant switched from electric to air tools, the company hadn't lost a single tool. Previously, employees snitched the universal electric tools to do some tinkering at home."

Business Week, April 25

Low-Upkeep Circuit Breakers

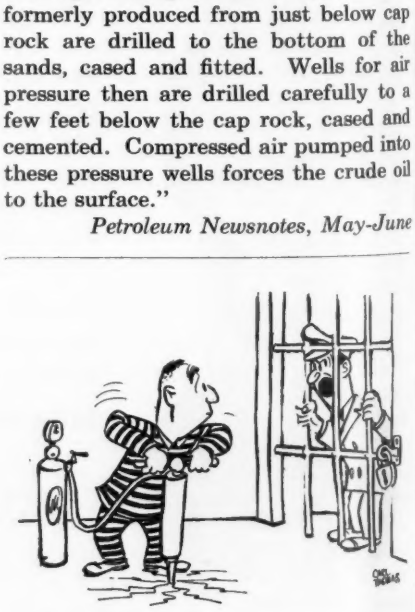
"Shop air lines supplying pressure of 65 to 100 psi will operate a new compressed air circuit breaker for arc furnace switching duty. So reported J. E. Schrameck and J. K. Walker, of Westinghouse Electric Corp., East Pittsburgh, Pa., on June 17 before the American Institute of Electrical Engineers in Atlantic City. They predicted: 'This breaker should be capable of two year's service with normal maintenance before replacement of contacts, arc chute splitters or working mechanical parts.' "

Steel, June 29

Compressed Air Recovers Oil from Old Wells

"Oil wells whose sands have been unproductive since 1922 now are yielding an average of ten barrels each per day from a new compressed-air method of recoverage. Using this method, wells that formerly produced from just below cap rock are drilled to the bottom of the sands, cased and fitted. Wells for air pressure then are drilled carefully to a few feet below the cap rock, cased and cemented. Compressed air pumped into these pressure wells forces the crude oil to the surface."

Petroleum Newsnotes, May-June



"Hey, you! Let's have less noise!"

Books and Industrial Literature

Diesel Publications, Inc., 192 Lexington Avenue, New York 16, N. Y., has announced the publication of the eighth edition of *Diesel Engineering Handbook*. The volume briefly outlines the fundamental principles of diesel engines and covers the various elements of design and construction in terms understandable to the average mechanic who is not always a technician. Mathematics as a means of explanation are used only where necessary for clarity, but intricate components such as fuel-injection systems are dealt with in detail. The book is divided into three general parts: land diesels and accessory equipment; marine installations; and representative types built by different manufacturers. Also included are specifications of all makes and models in production at the time of revision. Price, $7.50 in U.S.A.; $8.50 elsewhere.

The latest addition to the Prentice-Hall Physics Series, *Mathematical Physics* by Donald H. Menzel, Professor of Astrophysics, Harvard University, and editor of the series of textbooks, is primarily concerned with classical physics but emphasizes those topics closely related to modern phases, either in technique or subject matter. Several topics seldomly presented—electron theory and general relativity—appear in considerable detail because an understanding of them is vital to the student of atomic physics. The book is designed for junior and senior courses in mathematical physics and is also suitable for the general reader provided there is a good background in differential and integral calculus. The methods used are not always the shortest in the mathematical sense, but this has been done purposely to develop the students' abilities. To explain a topic more fully or to demonstrate the superiority of a new technique, there is some deliberate duplication; and intervening steps and auxiliary argument in the development of a formula are given in greater detail than usual. As far as possible, assumptions and postulates have been distinguished from conclusions that follow directly from analyses. Publisher, Prentice-Hall, Inc., 70 Fifth Avenue, New York 11, N. Y. Price, $11.35.

A new technical booklet giving information about Vinsol, its properties and applications and the forms in which it is available can be obtained from Hercules Powder Company, Wilmington, Del.

The A. K. Allen Company, 57 Meserole Avenue, Brooklyn 22, N. Y., has published a new catalogue covering its complete line of air valves, clamps and replacement parts with price list.

Tenac, a free-flowing, fast-setting adhesive lubricant for open gears and cables is discussed in a folder obtainable from E. F. Houghton & Company, 303 W. Lehigh Avenue, Philadelphia 33, Pa.

Two new leaflets, Nos. 404 and 504, being distributed by Federal Electric Products Company, 50 Paris Street, Newark, N.J., describe, respectively, its Noark manual motor control and its line of magnetic motor starters. Size, rating, capacity and design features of each product are dealt with and applications are discussed.

A new brochure illustrating and enumerating applications of Sheppard-Diesel industrial tractors equipped with Baker-Lull Shoveloaders can be obtained by writing to Baker-Lull Corporation, 376 W. 90th

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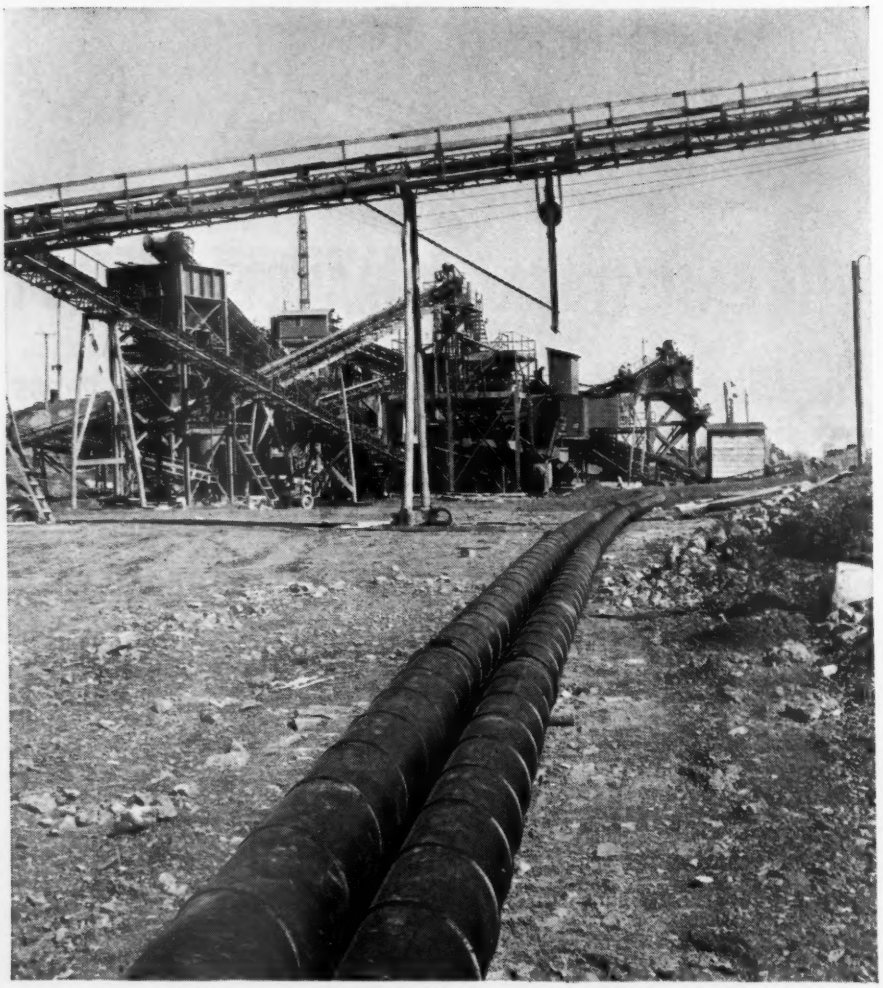
SUPER-HIGHWAYS FOR WATER



When it comes to traffic in water, you can depend on Naylor lightweight pipe for uninterrupted service. This distinctive lockseamed, spiralwelded pipe gives you lines that are extra strong, safe, leaktight. Naylor pipe is easy to handle and install—especially with Naylor Wedge-Lock couplings to speed connections. Sizes from 4 to 30 inches in diameter. Write for Bulletins No. 507 and No. 513.

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New York Office: 350 Madison Avenue, New York 17, New York

Street, Minneapolis 11, Minn., for Form A5201-1. Chief features of the equipment are listed, with attachments available.

Catalogue 1043C released by Hauck Manufacturing Company, 124-136 Tenth Street, Brooklyn 15, N. Y., is intended to help foundrymen select oil or gas burners, torches or heaters, including new units designed by the company.

Askania Regulator Company, 240 E. Ontario Street, Chicago 11, Ill., offers Bulletin No. 161 descriptive of its edge position control that keeps paper, textiles, metal foil, etc., in web form within the limits of the path it travels during manufacture.

Soldering irons and tips are dealt with in Bulletin GEA-4519 being distributed by General Electric Company, Schenectady 5, N. Y. In addition to photographs and diagrams that show their construction and application, a chart describes the purpose of flux and specifies which to select for a given base material.

If interested in fire pumps, Ingersoll-Rand Company, 11 Broadway, New York 4, N. Y., or any of its branch offices, will send you a bulletin (Form 7226) describing its line of horizontal single-stage and vertical multistage pumps approved by the National Board of Fire Underwriters and Associated Factory Mutual Fire Insurance Companies for hose-line and sprinkler systems.

Three informative pocket-size booklets on the selection and operation of hand and power hack saws and band saws can be obtained from The Capewell Manufacturing Company, 60 Governor Street, Hartford, Conn., or its distributors. They are the result of more than two years of field research and contain much other information on the subject of help to users.

L. B. Foster Company, supplier of railroad trackage and accessories, is distributing an illustrated 43-page catalogue—No. 575A—on switch materials. It deals with everything that comes under that head and contains a section that tells how to install frogs, switches, etc. Copies are available at the company's offices at Pittsburgh 30, Pa.; New York 7, N. Y.; Chicago 4, Ill.; and Houston 2, Tex.

Catalogue No. B-4 published by The Cincinnati Shaper Company, Hopple, Garrard and Elam Streets, Cincinnati 25, Ohio, deals primarily with its line of press brakes for sheet-metal and plate fabrication. A 72-page book, it shows the machines and their operating features and also devotes space to the fundamentals that enter into the selection of a press. It is sent free upon request.

Combustion gas turbines for mechanical drives is the subject matter of a 24-page booklet released by Westinghouse Electric Corporation, Box 2099, Pittsburgh 30, Pa. Four types manufactured by the firm—1800-hp and 7000-hp simple open-cycle, 5000-hp compound open-cycle with regenerator, and 5300-hp compound open-cycle—are described and represented by colored cut-away drawings. Write for B-5859.

Curing Intricate Cores with Dielectric Heat, an article that appeared in Allis-Chalmers Electric Review, is now available in reprint form from Allis-Chalmers Manufacturing Company, 1000 S. 70th Street, Milwaukee, Wis. It traces the development of the dual-heat core drier and discusses the preparation and curing of cores as well as core assembly and casting. The company's Foundromatic core drier is also described.

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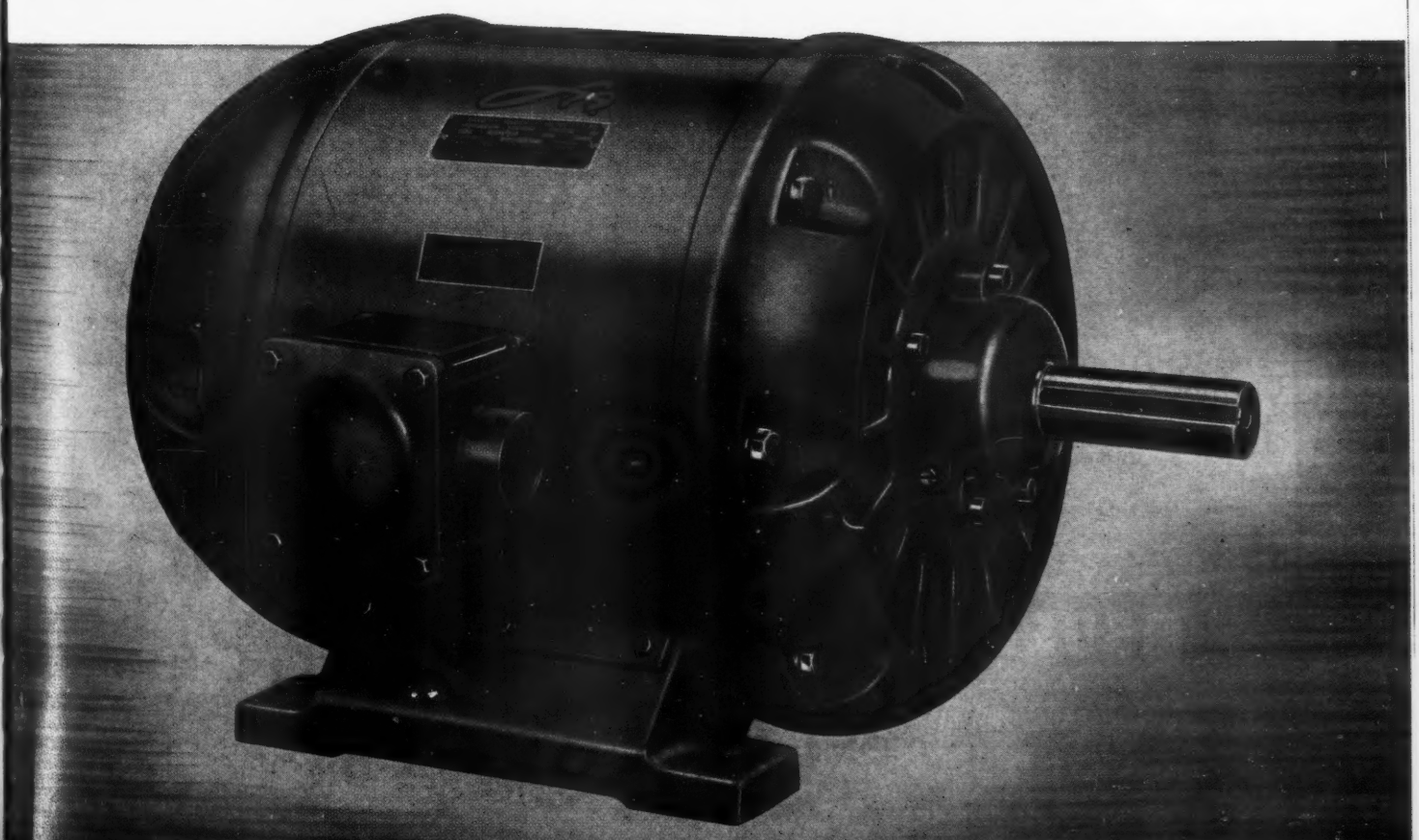
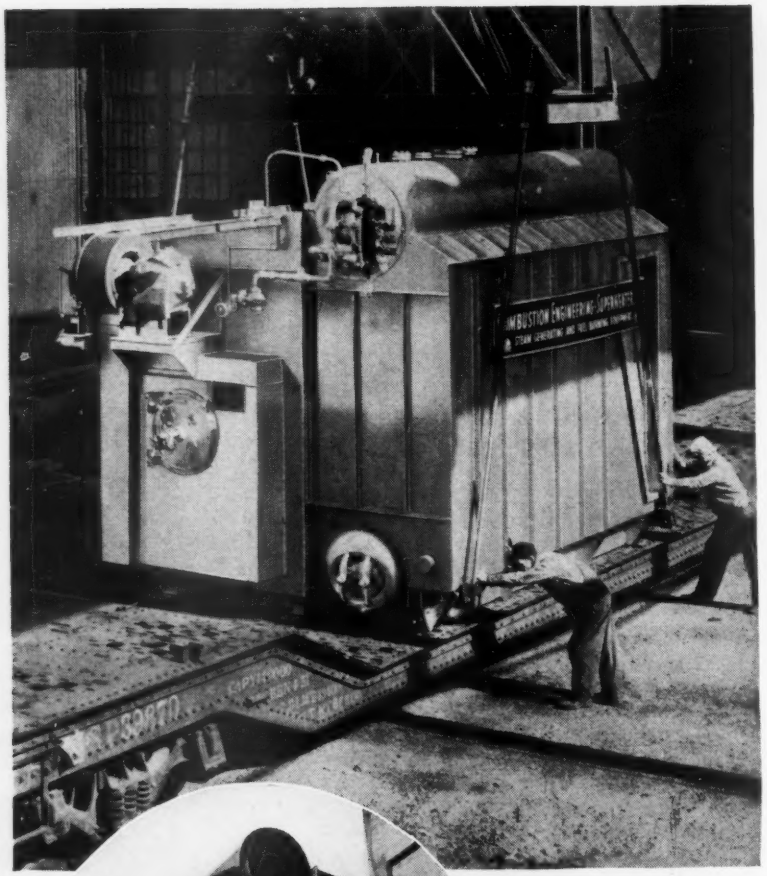


Don't settle for just A Package Boiler

INVESTIGATE THE VP BOILER



...the Package Boiler with EXTRA features

If you're in the market for a Package Boiler, here's the problem you face. There are a number of water-tube package boilers being offered today. Most of them look pretty much alike. And, in some respects, they *are* alike.

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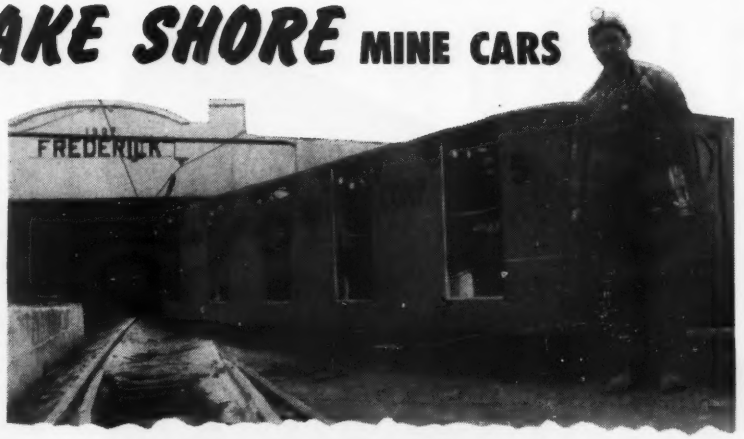

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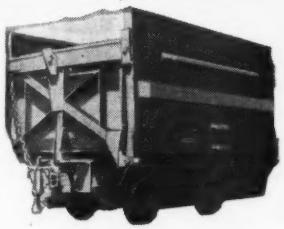

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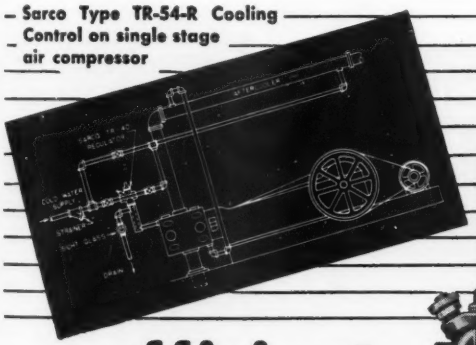

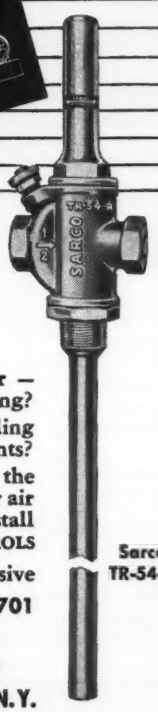

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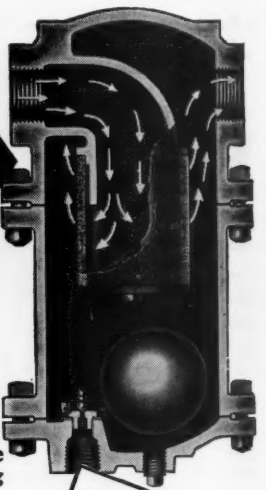

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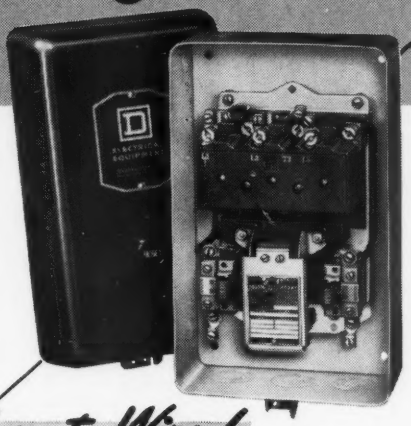

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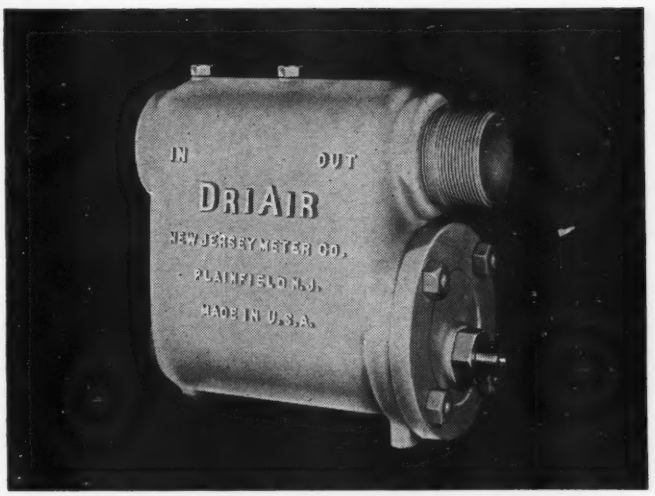

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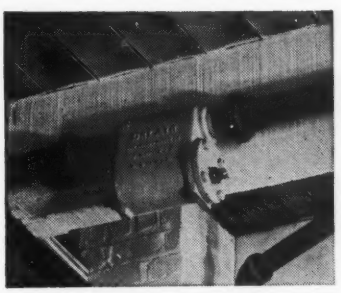

DriAir may be installed by suspending it from the piping, without any other support, or may stand on the floor near equipment being protected.

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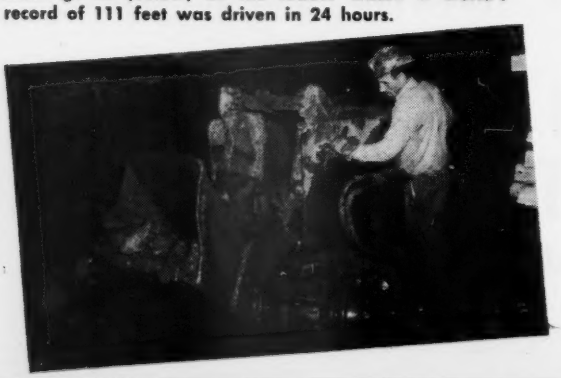

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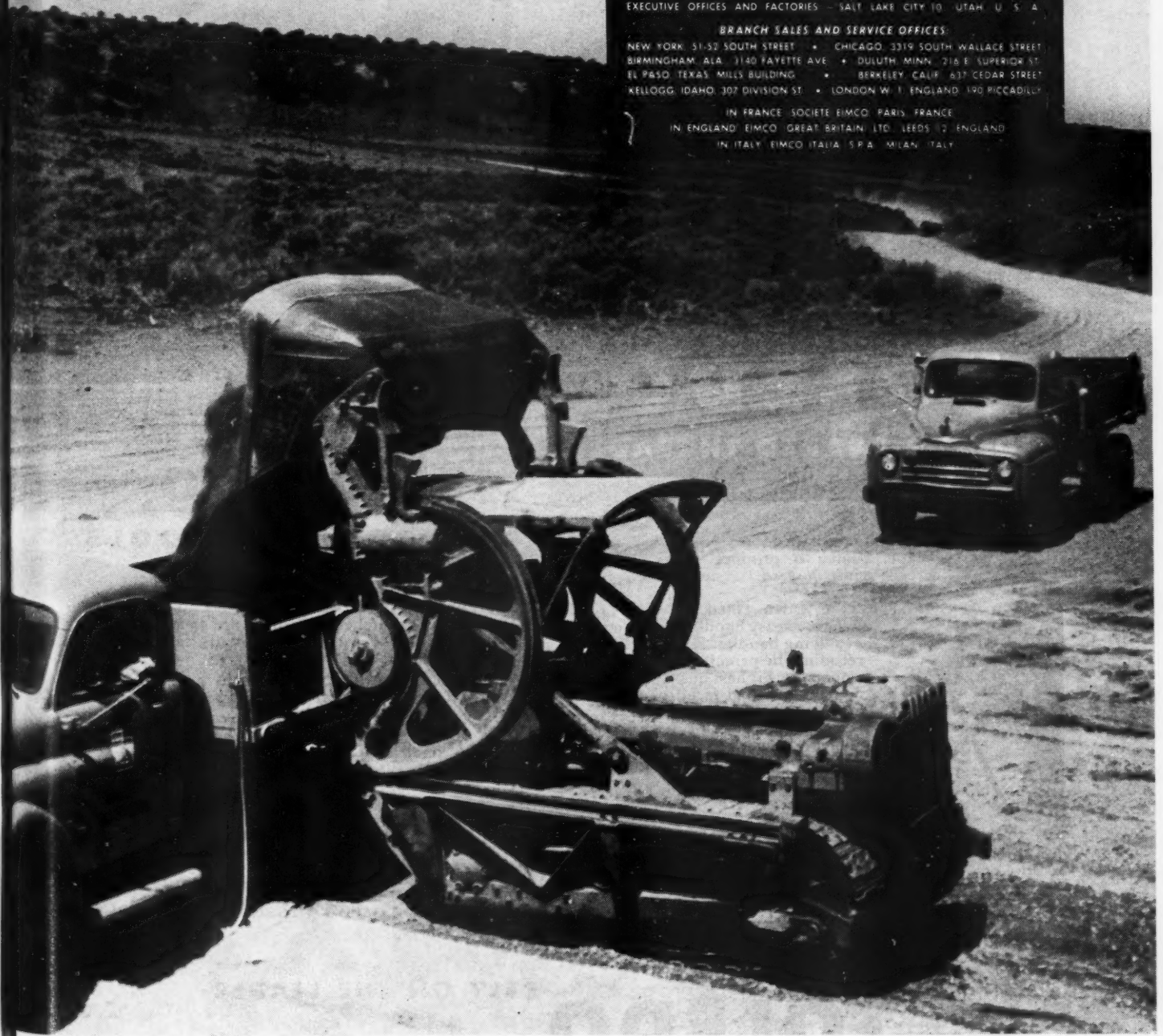

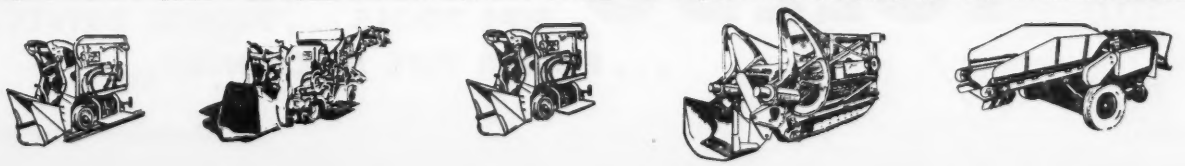

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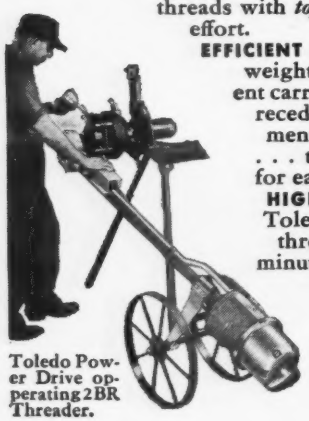
NO. 2BR GEARED THREADER

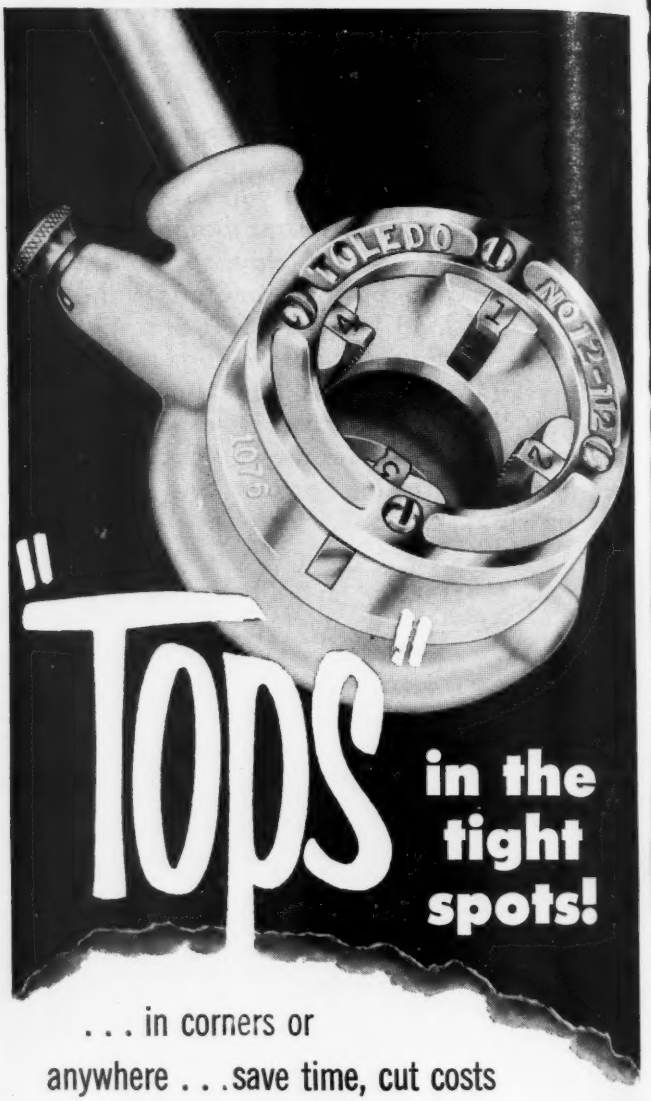
Put this popular Toledo on your 2½" to 4" pipe. Watch it produce perfect tapered threads with *top-speed* . . . and a *minimum of* effort.

EFFICIENT HAND OPERATION... Light weight . . . easy handling. . . convenient carrying handles. Employs Toledo receding die principle . . . 5 die segments . . . highest quality tool steel . . . three broad faced chuck jaws for easy centering.

HIGH SPEED... Operated with a Toledo Power Drive, the 2BR will thread 4" pipe in less than 2 minutes!



Toledo Power Drive operating 2BR Threader.



"TOPS" in the tight spots!

. . . in corners or anywhere . . .save time, cut costs with **TOLEDO**

DROP HEAD TOOLS

HANDY FOR CLOSE CORNER JOBS. These popular Toledo Ratchet Threaders are small, light, compact. Produce clean-cut threads easily . . . anywhere!

QUICK CHANGE OF SIZES. Die heads drop into ratchet from either side, held securely.

DIES OF FINEST TOOL STEEL. Precision-ground. Die segments can be reground when dull or replaced at small expense. These models: No. 00—⅛" to ¾"; No. 11—⅛" to 1¼"; No. 12—½" to 2" pipe.

ORDER THROUGH YOUR SUPPLY HOUSE . . .

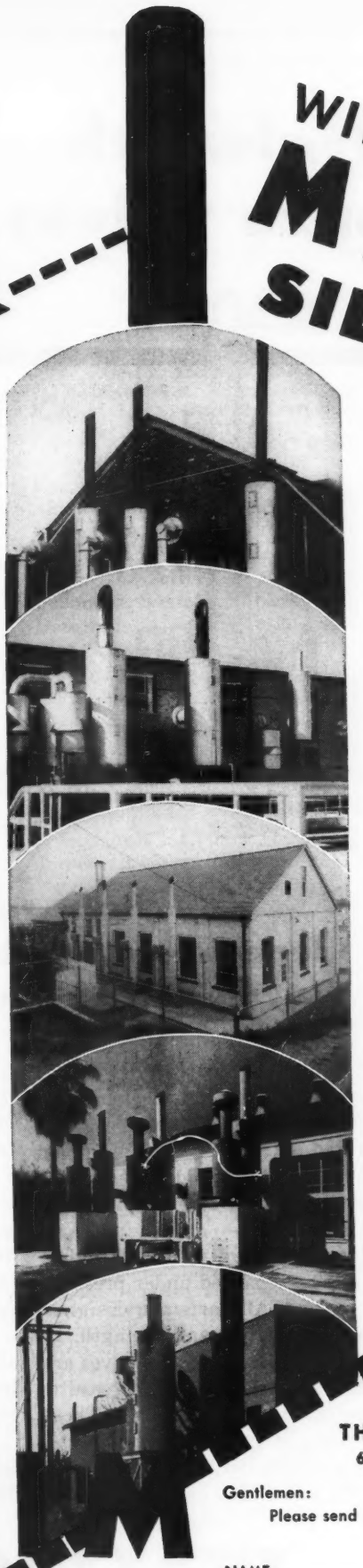
Write for catalog 11A-52. The Toledo Pipe Threading Machine Co., Toledo, Ohio. New York Office 165 Broadway, Room 1310.

TOLEDO

RELY ON THE LEADER

PIPE TOOLS . . . POWER DRIVES . . . POWER PIPE MACHINES

YOU'RE ALWAYS A GOOD NEIGHBOR---- WITH MAXIM SILENCERS



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Because silencing needs vary so greatly, good engineering advice to start with is almost as important as the product. Maxim engineers know municipal plant problems, and can be of real assistance in planning efficient installations. They are at your service.

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THE MAXIM SILENCER COMPANY
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Gentlemen:
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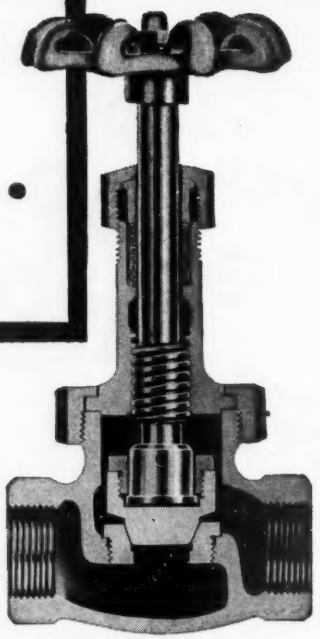
Walworth bronze valves...



Walworth No. 225P Globe Valve
500 Brinell Seat and Disc

Walworth
No. 29 Gate Valve

Walworth No. 95 Globe Valve
Re-New-Disc

built to give dependable trouble-free service on all recommended jobs

Walworth No. 95 Bronze Globe Valves (Angle Type: No. 96) are recommended for service where throttling is not required. They are rated at 150 psi working steam pressure, 500F; 300 psi cold water, oil or gas. The improved renewable disc and lock-on, slip-off disc holder — an original Walworth development—saves time and trouble. This valve can be repacked under pressure when fully opened. All parts are designed to give maximum service and strength.

Walworth No. 29 Bronze Gate Valves are rated at 200 psi working steam pressure, 550F; 400 psi cold water, oil and gas. These valves have rising stems and integral seats. Sizes 2-inch and smaller have union bonnets; sizes 2½ and 3-inch have bolted bonnets. Valves up to and including ¾-inch have solid wedge discs; 1-inch and larger have split wedge discs. These valves can be repacked under pressure when fully opened.

Walworth No. 225P Bronze Globe Valves (Angle Type: No. 227P) are rated at 350 psi working steam pressure, 550F; and 1000 psi non-shock service on cold water, oil and gas. The stainless steel, plug type seat and disc — heat treated to 500 Brinell — can be closed on sand, slag, scale and similar floatage, without injury to the seating surfaces. They are the longest wearing, TOUGHEST bronze valves you can buy.

For full information about Walworth Quality Bronze Valves, see your Walworth distributor, or write:

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